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The Mining Journal,

RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

No. 1858.—Vol. XLI. LONDON, SATURDAY, APRIL 1, 1871. PRICE ..... FIVEPENCE. PER ANNUM, BY POST, £1 4s.

Original Correspondence.

COLLIERIES IN NORTH DURHAM, THEIR WORKINGS AND MACHINERY—No. XIV.

The LUMLEY and HARRATON COLLIERIES form the second section in our description of the Earl of Durham's Lambton Collieries, and are under the viewership of Mr. Thos. Robson. From being at one time extensively worked, and the most important collieries of the Wear district, they had of later years greatly declined, owing to the coal from two of the best seams being almost finished in the first process of bord and pillar working, but large areas of pillars of excellent coal were thus left, which are now being got, although the bords have become filled up from the heaving of the sub-strata. Probably one-half of the whole area is standing in pillars in the Main coal and Hutton seams; the size of these is chiefly 20 by 8 yards, but many are smaller than this. In the Five-quarter seam more whole coal remains: the Maudlin, Low Main, and Brass Hill seams are, in comparison, but little worked, whilst the lower seams—the Busty Bank and Brockwell—are as yet unproved. The total area of mineral property included in the Lumley and Harraton Collieries is about 6500 acres; about one-half of this quantity is attached to each colliery. Within the last eight years they have been resuscitated, tracts of whole coal left, and some under new leases, are being worked, the old pillars are being extensively regained, and a comprehensive system of underground engine haulage is in operation at each pit.

LUMLEY COLLIERY.—This property is leased from the Earl of Scarborough. About 40 pits have been sunk on the estate, 12 of which are put down to the Hutton seam. Coal has been worked on this estate probably for upwards of three centuries. In 1676 there is a record that Lumley Colliery, with those at Heaton and Jesmond, were drained by means of chain-pumps worked by water-wheels. In North's "Life of Lord Keeper North" he states that "in 1676 Lord North was curious to visit the coal mines in Lumley Park, which are the greatest in the North, and produce the best coal, and being exported at Sunderland distinguished as of that place. These collieries had but one drain of water, drawn by two engines; one of three stories, the other of two. All the pits for two or three miles together were drained into this drain. The engines were placed in the lowest places that there may be less way for water to rise, and if there be a running stream to work the engines it is happy. They are twelve months in sinking a pit. Damps or fouled air kill insensibly; sinking another pit that the air may not stagnate is an infallible remedy; they are most affected in very hot weather. The blast is mighty violent; men have been saved by lying flat on their bellies. When they are by the side of a hill they drain by a level carried a mile underground, and cut through rock to the value of 5000*l.* or 6000*l.*"

An ancient adit, about one mile in length, is still in existence and partly open in the Lumley property. It commences near the river Wear, at the New Bridge, and follows the course of the ravine which passes behind Lumley Castle. Numerous staples have been put down on its course, from each of which coal is supposed to have been raised. The adit is commenced, it is thought, in the Five-quarter seam, but the work has evidently not been accomplished without difficulties, as it is driven in stone in a large part of its course, and in a lower seam in another part. This is probably the level referred to in Lord North's description, and the engines may be the chain-pumps driven by water-wheels. It would also appear from his description that explosions were occurring in coal mines in those days, though there are no records so far back. The explosions that have occurred in the Lumley Collieries, so far as recorded, are given below.

Date.	Name of Pit.		
1799—Oct. 11	Lumley Fifth Pit.....	39	lives lost.
1817—Nov. 30	Houghton Gate Pit.....	2	"
1819—Oct. 9	George Pit	13	"
1824—Oct. 25	George Pit	14	"
1827—July 20	Charles Pit.....	1	"
1833—May 28	Lumley	2	"

The accident in 1833 is the last on record, though the colliery has been carried on under considerable difficulties since that, both with reference to ventilation and tapping abandoned workings filled with water and gas at very high pressure; fortunately no accident has resulted from these operations. At the present time coal is raised from two pits only, the Second pit and the Sixth pit.

The SECOND PIT is supposed to have been sunk about 200 years ago. It was suspended for some time, and has been deepened at different stages; it is now sunk to the Harvey seam, 76 fms. in depth, 8½ ft. in diameter. The First pit, near to it, is used exclusively as a downcast. The upcast is above one mile distant, in the Chester property. The winding-engine at the Second pit is a condensing beam-engine of 30-inch cylinder, 5-ft. stroke, two 9-feet flat-rope drums, it raises about 220 tons of coal per day, with one two-decked cage and rope; with the other rope water is raised by day and night in an iron self-acting tank, carrying 400 gallons. To supply this engine and two underground engines with steam there are five plain boilers, 30 to 35 ft. in length, 6-ft. in diameter, flash-flued; and one Lancashire boiler, 30 by 6½ ft., with two 2½-ft. tubes; all these are uncovered. One boiler produces steam at 15 lbs. pressure for the winding-engine, the five others at 30 lbs. per inch for the engines underground. The boiler feeder has a 10-inch annular piston, the ram, being hollow, is within the piston, the connecting rod is attached at its lower end. There are five screens at this pit, of iron; the heapstead, inclined elevator, and other framing are of wood.

The hauling engine is erected about 30 yards north from the pit bottom, in the Harvey seam, on high stone pillars, with the drums overhead, the wagon roads passing between the pillars. It has two 20-in. horizontal cylinders, 4-ft. stroke; two 6-ft. drums, on separate shafts, each drum with a clear front; one pinion and two spur-wheels, in the ratio of 17 to 20. The tail drum is moved by slide carriages; the other drum is put in or out of gear by clutch; from the end of its shaft a pump is worked direct by crank. The engine-road proceeds north from the pit until the Woodstone House fault is crossed, which throws down the measures to the north 22 fathoms; this dislocation makes the Hutton seam nearly level with the Harvey seam. The engine-road afterwards proceeds west In the Hutton seam, and then south-west into the Chester property, the coal in which has been extensively worked and brought to the pit by this engine; it is now being worked homewards. The length of the engine-road is 4500 yards, or over 2½ miles from the pit to the return wheel; 42 tubs are run with each set; time in running in, 30 minutes. Main and tail ropes, of steel, are used throughout. There is a rising gradient inwards. The total rise between the pit and extremity is 204 ft. The hauling-engine also works a vertical double-acting pump, 9-inch plunger, 22-in. stroke, from the main drum shaft, going at night only, at the rate of 25 strokes per minute. It forces water up the pit 64 fms., to an adit 11 fms. from the top, by 8-inch mains; at 10 gallons per stroke it will deliver 250 gallons per minute. Another pump, placed diagonally, is worked occasionally by this engine; it is a 6-in. close-topped lift, 4-ft. stroke, single-acting, and raises water to the Hutton seam, 22 fms. in height; at the rate of 20 strokes it delivers 100 gallons per minute. No. 2 pumping-engine is placed near the other, and forces up to the adit (64 fms.), both day and night; it has one 22-in. horizontal cylinder, 3-ft. stroke, direct-acting, working a 7-in. horizontal double-acting pump, at the rate of 25 strokes per minute. Provision is made for placing a duplicate engine and pump, if required. At 9½ gallons per stroke the quantity delivered per minute will be 237 gallons. The water from both pumps passes through the same mains, and unitedly amounts to 487 gallons per minute. Steam is brought from the surface boilers down the second pit in 10-in. pipes, to a receiver near the engine. The escape steam is taken up the same pit, and some distance further on the surface, in pipes. The heat radiated from these pipes causes the second pit to be an upcast. The air from the downcast has liberty to go either direct to the second pit, or into the workings and the only other means of egress—the Chester upcast. About 70,000 cubic feet is found to go into the Chester workings, and 35,000 cubic feet up the second pit. In the Chester district coal is got on the bord and pillar system, the pillars being made 30 yards by 14 yards, bords 4 yards, walls 2 yards wide. A winding beam-engine stands at the top of the third pit, used only for raising men in case of need, with 27½-inch cylinder, 4-ft. stroke, two 6-ft. drums, and two lain boilers. Steam pressure, 25 lbs. Depth to Hutton seam, 50 fms. Gasworks are erected near the second pit, comprising nine retorts of fire-clay, one coke-scrubber with water passing, two dry lime purifiers; gas-holder 20 ft. in diameter, 10 ft. depth; 161 gaslights are supplied, 80 of which are underground, at and near the bottom of the pit and engine rooms.

The workshops at the Second pit are the principal for Lumley and Harraton Collieries, consisting of joiners', smiths', and fitting shops. A horizontal engine, with one 14-inch cylinder, 2½-feet stroke, and Cornish boiler, 16 by 4 feet, tube 2½ feet, pressure 28 lbs., drives two lathes, one screwing-machine, one drilling-machine, and one boring-machine. It also drives (from the fly-wheel by belts) circular saws from 1½ to 4 feet in diameter, and the fan for supplying with blast eight smiths' fires.

THE SIXTH PIT.—This, in its original state, was 8½ ft. in diameter. After standing 50 years it was re-opened seven years ago, and enlarged to 12 feet in diameter as a downcast and coal pit, and was fitted up with new plant, six iron screens, elevator, heapstead, and framing of wood. A winding lever-engine, built by T. Murray and Co. in 1863, has a 30-inch cylinder, 5 feet 8 inch stroke, 10 feet cylindrical drum, wrought-iron levers. The drum and fly-wheel are supported by wood framing, the house is also of wood. About 540 tons of Hutton seam and Low Main coal is raised per day from the Low Main "hanging-on," 80 fms. depth, with single-deck cages, two 8½-cwt. tubs in each deck. Two wrought-iron tanks, carrying 500 gallons each, are provided for lifting water by the winding-engine, in the event of a stoppage of the present pumping-machinery. Two plain boilers, flash-flued, 28 ft. in length, 5½ and 6 ft. in diameter, and two Lancashire boilers, 30 by 6½ feet, tubes 2½ feet in each, supply steam at 30 lbs. pressure to the winding-engine and an underground engine. The boiler-feeder is a 7-in. ram, driven by a 10-in. inverted engine, 8-in. stroke, by J. and G. Joicey. The hauling-engine, by T. Murray and Co., is placed in the Low Main seam, in a spacious chamber, south of the pit, this with the approaches to the mine, are lighted by 70 gaslights, the gas being derived from works at the top of the pit. The engine has two 26-in. horizontal cylinders, 5-ft. stroke, two 6-ft. drums on separate shafts, one pinion and two spur-wheels, all of equal size; the drums have a clear front, and are put in or out of gear by slide-carriages. Two pumps are intended to be worked by this engine, direct from the back piston-rods, so as to force water to the top of the pit. The colliery being heavily watered, the object sought to be attained by attaching these pumps is to relieve the large pumping-engine at Lambton (hereafter referred to) of part of its duty. And in conjunction with lifting by the tanks named above, there would be provided independent drainage power, to be substituted in any emergency for that engine.

The engine-roads in the Low Main seam branch off in three directions from the landing at the bottom of the pit (west, south-west, and north); 42 tubs are run with each set. The landing is about 90 yards in length south from the pit; at 20 yards east of its inner end the engine is placed. The west engine-road, 598 yards in length, is in line with the engine; it is cut through the Woodstone fault, a rise south of 22 fms. There being 14 fms. of strata between the Low Main and the Hutton seams, this fault makes the Hutton seam on the top of it 8 fms. above the Low Main at the dip side; this difference is overcome by a rise drift driven at 6 in. per yard. The empty tubs are pulled in by the tail-rope to the bottom of the drift, where the main rope is disconnected, and the tubs are pulled in to the extremity with the tail-rope only; the laden tubs are brought out *vice versa*. The south-west engine-road, commencing from the shaft landing, is 530 yards in length. It is cut through the Woodstone fault in a similar manner to the other, to gain the Hutton seam. This branch is on a rising gradient, and is worked by tail-rope only. The north engine-road branches out of the west one, about 50 yards from the engine, and is extended 1122 yards northward to the Low Main workings; both main and tail-ropes are used for this side. Near to its extremity is the Houghton-gate pit. A large area of pillars in the Hutton seam, belonging to this and the Whitehouse pit, will be commanded by the north engine-road. A fault rising 10 fms. north traverses this district. The Hutton seam, on the rise side of it, will be reached by a dip drift from the Low Main, 4 fms. This portion of the workings, on the rise side of the fault, has been for 50 years shut off by a dam of great strength, inserted close to the Houghton-gate pit; the dam was formed of bricks and cement. 7 yards in length, 4 yards in width, and the height of the seam; a 2-inch pipe through it was carried up to the top of the pit. This dam has lately been removed with considerable difficulty.

Ten-inch steam pipes are brought from the surface boilers to the hauling engine down the Sixth pit, as far as the Maudlin seam. In that seam they are taken along an arched drift, and down a staple to a receiver placed near the engine. That part of the pit where the pipes are fixed is bratticed off, which prevents the injurious effect of heating the downcast air. The steam from the engine escapes into the arched flue in the Maudlin seam, 4½ ft. by 4 ft., which is continued to the upcast or Seventh pit, a distance of 270 yards. There are two drop staples at the back of the Sixth pit, each being provided with a 6-ft. drum and brake to regulate the descent, placed at one side of the top. At one coal is dropped 21 fms. from the Main coal seam, but the Low Main is also gained by cutting the Woodstone fault, which brings the Low Main on the rise side nearly level with the Main coal on the other. At the other Five-quarter coal is dropped 33 fms., but the working of this seam is at present suspended.

The Five-quarter coal was being got successfully on the long-wall principle. A face of 150 yards has been carried up 200 yards westward, with four goaf-roads formed in it, 38 yards apart. These roads are supported by two yards of pillaring on each side. The space between them falls readily; this affords building stone, and relieves the weight on the pillaring. The other seams are worked on the bord and pillar system, but old pillars are now being worked to a great extent, as before remarked. The coal of the Hutton seam is structurally strong; usually the weakest part is the floor, which heaves up so as to fill the excavated parts. The thrust or weight of the superincumbent strata (the tendency of which is to crush the pillars when they are made too small, or the coal is weak) is thus moderated by the heaving and filling up of the old bords. The historical examples we have given serve to show the hazardous nature of coal mining at the early period. Since 1833 no explosion has occurred. This must be attributed to increasing largely the currents of air, to a better system of ventilation, and the extended use of lamps. Before the end of this century no doubt greater advances will be made; ventilation by machine will be the rule, the use of powder prohibited, and more perfect lamps introduced. These, with a perfected system of ventilation, and attention in carrying out the rules of every mine, will reduce accidents to a minimum.

The following are the thickness and depth of workable seams at Lumley, as far as the strata have been proved:—

	Thickness.		Depth.
1.—Five-quarter Seam	3 ft.	2 in.	47 fms.
2.—Main Coal Seam.....	6	0	59 "
3.—Maudlin Seam*	4	6	72 "
4.—Low Main Seam.....	4	0	80 "
5.—Brass-thill Seam†	3	4	86 "
6.—Hutton Seam	4	4	94 "
Coarse coal	0	4=4 ft. 8 in.	
7.—Harvey Seam—Coal	1	10	114 "
Fire-clay	2	0	

* Including 3 in. of stone, 1 ft. from the bottom.
† Oil shale roof, including 2 in. stone band, 8 in. from bottom.

The fire-clays under the Main Coal and Harvey seams are good in quality, the others have inferior fire-clays. The ventilation for the whole of the Sixth pit workings is caused by heated column of 80 fms. in the Seventh pit, and a furnace 14 ft. square at the bottom of it. The amount of air in circulation is 120,000 cubic feet per minute. No horses are employed in the Second and Sixth pits; small ponies convey coal from the face to the termination of the engine roads.

Of the pumping engines on the surface the principal one is on the dip side of the property, in Lambton estate. It is a beam condensing engine, made by T. Murray and Co., in 1852, and raises water in two lifts. Cylinder 76-in., 7-ft. stroke, 28-ft. beam, wrought-iron shaft 11 ft. in length and 5 tons weight, fly-wheel 20 tons. From the end of the shaft a crank and connecting rod give motion to the pumping beam below, 40 ft. in length. A pit is sunk 100 fms. at the crank end, and a staple is sunk 50 fms. at the opposite end of the beam, with a drift of communication at the bottom. The lower lift, 50 fms., with two 18-in. buckets, is in the pit; a similar lift is placed in the staple, stroke in each 6 ft. The engine is in action day and night, at the rate of 7 strokes per minute. Calculated at 130 gallons per stroke, the engine at this rate will raise 910 gallons per minute from the depth of 100 yards. The jack-head pump, with 20-in. bucket, 3-ft. stroke, supplies the condenser from the landing-box of the staple pumps. The vacuum gauge indicates 11 lbs. per inch. A part of the water flowing to this pit is saline, and was at one time used in the manufacture of salt; this is now discontinued. The engine is supplied with steam at 12 lbs. pressure from seven plain boilers, flash-flued—three are 24 by 7½ ft.; four, 33 by 7 ft. The boiler feeder is a 10-in. inverted cylinder, 8-in. stroke, working a 7-in. ram.

The Peelflats pumping-engine is on the same principle as the Lambton engine; it has 23-in. cylinder, 4-ft. stroke, non-condensing, raises water in two lifts from the main coal to the surface, 33 fms. The lower lift in the pit, 16½ fms., one 14½-in. bucket; the upper lift in a staple the same; the stroke in each 5 ft. 2 in. This engine will deliver 45 gallons per stroke; at the rate of five strokes per minute 225 gallons are lifted day and night. This engine is situated on the rise part of the property, and intercepts the water which would otherwise flow to the Lambton engine, and be lifted there from a greater depth.

COAL AND IRON IN SUSSEX.

SIR,—On seeing a letter in the Supplement to last week's Journal, signed "G. T.," headed "Coal and Iron in Sussex," I referred back to the *Mining Journal* of March 18, and found a very interesting account of the "Ancient Iron Trade of Sussex," in which it states that in 1825 "the last forge at Ashburnham was closed," in consequence of the want of fuel for smelting purposes. In the letter from "G. T." he states—"While sinking a well deeper here, from 60 to 90 feet, I saw baskets-full of coal brought up, and as a proof of its good quality iron was welded with it." And he adds—"I believe the day is not far distant when Sussex iron ore will be smelted with Sussex coal." We find in a work entitled "The Two James's and Two Stephenson's," that in 1806 Mr. William James (a solicitor, and founder of our railway system), embarked with the late Lord Whitworth, the Duchess of Dorset, Mr. Vansittart, Mr. William Whitmore, of Birmingham, and others, in a very extensive trial for coals at Bexhill, in the county of Sussex, in which upwards of 30,000*l.* was expended without success, in consequence of the quantity of the water they had to contend with. After expressing his wish for Mr. Whitmore to send more boring-rods immediately, he says—"Conceiving this a very important crisis, I am, I confess, very anxious to get the hole proved (in my pre-

sence)." It may be possible that the coal spoken of by "G. T." having been found at Warbleton may be part of the strata found at Bexhill in 1806.—*March 27, 1871.* E. M. L. P.

LECTURE ON COAL.

COAL: WHAT IT IS—WHERE IT IS—HOW IT CAME THERE, ETC.

The following paper, on the above subjects, alike interesting and exhaustive on Coal, the mode of raising it, and the extent of our coal fields, was read at Castleford, by Mr. J. WARBURTON, of Normanton, the well-known mining engineer. After some prefatory remarks, the paper opened with some observations as to the formation of coal, and then went into its constituents, as follows:—

I. *What Coal is.*—The main elements in wood and coal consist of carbon, hydrogen, and oxygen, with a few other substances in very small quantities, so small that for our purpose we shall dismiss them. In coal carbon forms by far the largest proportion, and in the coal farthest removed from woody appearance is the most carbon found. But the increase of carbon and the decrease of oxygen and hydrogen are so gradual, that the line where woody matter ceases to be wood, and coal begins to be coal, is not very easily defined. A protracted lawsuit was instituted in Edinburgh to try the question "What is coal," in the year 1853, in which the best chemists, microscopists, mineralogists, and geologists, scientific and practical, were called. A gentleman had a lease of all the coal under a certain acreage. In process of operations he discovered that the material in question was very rich in mineral oils, and began to work it for such. The demand was so great that he was able to make enormous profits. The landlord did not like to see this, and not able to share the increased value; so he got up an action at law, and was able to find very many men of science to state in evidence, before the "Lord Justice General" and a special jury, that the substance in question *was not coal.* There were as many men of acknowledged science on the other side to prove that this very substance *was coal.* After hearing this kind of contradictory statements for five days, the Judge ignored the whole of the evidence, and said, "To find a scientific definition of coal after what has come to light within the last five days, is out of the question."

The received notion of what *coal* is has been that it is a substance, not being wood, which will burn and maintain a fire. I am not in a position either to affirm or dispute such a statement. But aside from this, and to consider "coal proper"—or that substance best known to English people as coal—we are in some measure able to see what it consists of. The greatest diversity appears when we come to define what I have called coal proper, and the shales that contain mineral oils, and possess all the properties of combustion, that our common coal does, but void of that characteristic fibre so distinct in the common English coal. The great difference in this case also is due only to the proportion of the elements that form the whole; for although physically there is such apparent difference, chemically they are the same in kind,—more of some and less of other elements make all the difference so manifest in appearance.

It will be seen how sensibly but gradually the carbon increases, while hydrogen and oxygen decrease, till we arrive at that kind of coal called anthracite, which is the farthest removed from woody tissue. We find by an analysis of Welsh anthracite that for 100 parts of carbon it has only 6·12 of other elements. Boghead and cannel belong to a species of coal the exact origin of which it is difficult to determine. The fibre and granulated condition is in a far less degree perceptible, but perceptible it is not with the naked eye. Its breakage also differs widely from common coal. That which has given rise to the terms "end and board" is not manifest in cannel coal. The more recently formed coals have very nearly all the characteristics of wood physically. Wood has its grain, as we call it—it is composed of long fibres, extending lengthways of the tree, and the cutting it up into boards is always done parallel to this fibre. The cuttings thus made from a balk of timber, or tree, are called *boards.* Coals proper have exactly the same fibre, but are never found at right angles or vertical to the bed on which the coal rests—the direction of the fibre is not from floor to roof, but horizontally. There are a few specimens here. This long piece is exactly like a board, and you will see its fibre running lengthways quite distinct. From this resemblance to woody boards we speak of coal presenting this broad side as coal *on board,* and the other view, at right angles to it, as *end,* which it really is. It has also another character like wood—conductivity of sound.

When a boy at school we used to conduct practical experiments by speaking from end to end of a balk of timber. We can also speak through a solid mass of coal, either board ways or end ways, but through a much longer distance end ways than board. This can very easily be accounted for. The sound going endways on the same unbroken fibre from the point it is given to the other end; boardways it is not so, as it must cross the fibre, and thus encounter far more resistance. All coals, except those farthest removed from vegetable matter, as anthracite, have this distinct fibre.

You will be able to see what elements constitute coal; but as to the proportion of these elements, how and when, in the stage of conversion, they have arrived at that which shall be called coal, I cannot say. How much carbon, or of anything else combined, shall be said to be coal has not yet been decided. So that it is still open what shall and what shall not be called coal. The gap thus left between what may be called coal at its commencement, and that the furthest in the scale is so wide that, in a commercial point of view, it is difficult to deal in.

From what we have seen I think it will be pretty clear that coal is of vegetable origin, and that its passage has been very gradual and sensible; and that it is chemically composed of the same elements as wood, differing only in quantity and degree, not in kind.

We will now consider the second part of our subject.

II. *Where Coal is.*—In treating this division it will be necessary to speak a little geologically; but not as a whole, only so much as is necessary to have a clear idea of the position of our coal. Happily our earth is not like an orange, only a similarity in form. As before named, it is composed of rocks; and these are so arranged in England and Wales that we can see and examine no less than 73,350 ft. in depth of them, and without descending deep pits. This thickness is exposed to open day, and can be examined by the aid of sun light. This appears paradoxical, but we shall soon be able to solve it. It is in the carboniferous system of rocks that coal is found. The average thickness of these rocks containing coal is some 5000 feet. Above the top of this 5000 feet come other systems of rocks of no less than an average thickness of 4850 feet. Now, if we talk about the shell of the earth we have one of 4850 feet covering the coal nearest to us, a depth we should experience some difficulty in breaking or pealing off to get at the coal; but had this been a shell, or crust, in the sense we understand these terms, coal would never have been discovered, but remained hidden beyond the ken and reach of man to the end of time.

Our coal is in the earth, and the nearest seam or bed is 4850 feet below the most recent formation, and the deepest seam is 9850 feet below it: a depth we do not contemplate arriving at. But by some law, or combination of laws, of Nature, we have in certain localities seams of coal brought right to the surface, and occasionally standing out from the surrounding rocks, as it were, looking at man, and asking to be taken into his service.

Like many other things of value, its presence was unheeded for centuries. The earliest recorded evidence of its being used is by a Greek author, named Theophrastus, who is said to have lived 240 years before the Christian era, consequently about 2111 years since. In modern times he is made to have said—"They call those fossil substances anthracite, and when they are broken up for use are of an earthy character; nevertheless they inflame and burn even like charcoal, and are much used by the smiths." This is said to be the first noticed use of coal which would be found on the surface. A glance at the large section will enable you to see how it is that it appears at the surface, and thus presenting itself finally became appreciated; but that it remained to be got at the surface, or found so ready to man's use and reproducing, like corn or other cereals, is not so. And although it is an article of such importance it is much better that it should be down in the earth, and covered up; indeed, its covering is an essential to its present condition; and to the lords of the land it is a source of great value, so much so that there are numbers of instances where the seam of coal alone produces more cash value to its fortunate owner than the sale of the whole estate were the seams of coal absent, and yet the surface land remains intact and as valuable as ever it was. How valuable must be an estate with so many seams, one lying beneath another, each representing a value equal to the sale of the surface land. It is, in fact, so many surfaces, and instead of reckoning a man's estate by so many superficial acres we may multiply that number by the seams underlying it. Thus an estate of 800 acres multiplied by 20, the average number of seams in seven of the more important districts, the result is an estate of 16,000 acres, about 15,000 of which you may dispose of, and still have as many acres to shoot over, if you are a sportsman; if not, when in town you can talk of *my* estate in the north, &c., or *my* estate in Wales. I can fancy a statement like this producing one of those complaints to which frail humanity is subject, commonly called "watering in the mouth," understood to indicate a peculiar desire of self-appropriation of the thing under consideration.

A glance at the Geological Map of England and Wales will convince you that a very small amount of England, small as she is, contains this valuable mineral. England and Wales are said to contain 57,813 square miles. The coal-bearing strata are about 3435 square miles, or about 1-17th of the whole area, made up of the following dimensions in their respective districts:—

	Square Miles.		Square Miles.
South Wales	900	South Staffordshire	93
Bristol	150	North Staffordshire	75
Forest of Dean	34	Warwickshire	30
Coalbrookdale	28	Leicestershire	15
Denbigh	47	Notts, Derbyshire, York..	1100
Flint	35	Northern, or Newcastle..	680
Lancashire	217		
Cumberland	25	Total	3435

In the northern coal field there are more than 200 square miles under the magnesian limestone and new red sandstone, the Monkwearmouth Colliery being sunk through these measures. A still greater amount is taken under the same strata on the east of the large Midland coal field. The shafts at Newton here just pass through them, and had it not been for the denudation by the course of the river the thickness of the limestone and sandstone would have been more than four times that now found there. Denaby and Shireoaks are also on the same line, and the order of strata comes in proper succession. The dip, or inclination, is in a south-easterly direction. The coal goes directly under the Permian measures. A seam of coal coming to the surface a little west of Leeds will be over 2700 feet deep at Denaby, so that we are pretty safe in assuming that in our own district coal will be found considerably east of what was formerly looked upon as the limit of this coal field. At Wearmouth a shaft has been sunk through the Permian strata and drift a depth of 330 feet before they reached the coal measures. At Newton old shaft there is about 21 feet drift and Permian strata ere the coal measures are met with. A little further north-east, in the direction of Fairburn, these measures amount to 169 feet above the true coal measures; and in the new shaft at Newton, which is nearer the river, the Permians are absent altogether, proving very clearly that these measures at one time extended in an unbroken flat from Fairburn across the present valley, joining the same measures on the other side.

The cause of these measures being now absent in the valley is owing to the course the current of the river has taken, which by force of bulk and speed has carried away not less than 150 feet in depth at the centre of the present river. This process in geology is termed denudation, and plays a very important part in geology.

Denaby Colliery, although practically in the Permians, has not passed through them in its sinkings, owing to the fact of its being in close proximity to the river Don, and the denudation by its currents, together with its position being in a recess, so to speak, as the eastern escarpment of the Permians has bays further inland; or, in other words, the Permian series come out in a kind of zigzag form. It is in one of these bays that Denaby shaft is sunk.

At Shireoaks, still further south, the shaft went through 196 feet of the Permian strata ere they met with the true coal measures, thus proving that coal may be expected under these measures, but at what distance as yet no one can say, though in all probability it will be found so far eastward under the new red sandstone and magnesian limestone as we shall like to go. But I would not like to venture a limit to depth, as so far appliances have been equal to any depth it has been necessary to go.

The two most prominent obstacles are pressure and heat. The former I do not consider of much moment; the latter, heat, may be an obstacle, but not a very serious one down to some 3500 ft., although, according to observations made variously, Prof. Hull says the temperature at that depth would be, the surface at 50°, 111·44°. I am inclined to think that in practice this would not be so high in a well ventilated pit. And I am not satisfied in my own mind as to the mode of experiments to ascertain the temperature of depths. Nor do I think the rule adopted as to the ratio of increase of temperature is upon a solid basis. Mr. George Elliot, M.P. for North Durham, had some valuable experiments made, and came to the conclusion that increassed temperature was due to pressure, and not to depth in the abstract—*i.e.*, if an entry to a seam of coal were made at the level of the sea, and proceeded in the seam under a mountain 600 ft. high, the temperature will be the same as in a seam 600 ft. below the level of the sea, so that our experiments on this subject are by no means complete. But should the temperature increase at the rate arrived at by several gentlemen—1° for every 70 ft., I have a hope we shall be able to reduce it considerably in the working places by passing currents of fresh air at moderate velocities, and, if need be, injecting on a large scale air compressed very high, so as to be delivered in the workings at freezing point. This, or some other means, will be got at whenever the circumstances require it.

Regarding the coal of this locality I must say a word or two. In the outset I may state this is a very interesting district geologically; being so near the collieries most eastwards, there is ample room for investigation, and especially as you have the limestone and New Red Sandstone within a stone's throw of the town. The seams already proved are sufficient to indicate what else there is beneath. At the most easterly colliery—Newton—you have the uppermost seams of value in the coal field. There are some few of little importance not there. The first of value is the Scale coal, which is of good quality, but very thin; then the noted "Stanley Main." At Newton this is rather thin, and not equal to what it is a little more west; but to compensate for this, the next seam below—"Warren House"—is much superior to the same more west, till we get into the district known as the South Yorkshire or Barnsley coal district where the Warren House assumes the magnitude of the Barnsley Thick coal, in most places about 9 feet of good coal. This seam is not to be despised; but the most important yet proved is the well-known "Haigh Moor" bed; this in this locality is considered *the* seam, and so far as proved is so. Next of moment comes the "Middleton Main," or Silkstone bed, not yet proved in this locality, but I have no doubt it will maintain its character as a good coal. The remaining beds of importance that may be expected below the Middleton Main are the Beeston and the Better bed, which will not be much over 1850 feet—a very small depth, as there are shafts now working deeper than that. There are several minor seams that might prove good and workable in this neighbourhood. I have a kind of hope that the Beeston and Low Moor beds will be found good in and about here.

From what has been said we shall all be satisfied that coal is embodied in the earth, and that there are seams of it at very great depths from the present surface. The greatest depth at which coal is being wrought in England is 2418 feet, at a colliery near Wigan, called Rosebridge. Deep as this is, I have no doubt that 20 years hence will see shafts over 3000 feet deep.

Having gone so far in trying to show that coal is of vegetable origin, and that it is in the earth so far from the influences which support and develope vegetation, we naturally glide into the third division of our subject—"How came it in the position we find it?" We proved in the first part that coal and vegetable matter chemically are identical, changed only in character and degree, the composition being the same elements; nor would it be a hard matter to prove physically, as well as chemically, that coal is of vegetable origin. Take a few of the specimens that are on the table, you will at once recognise perfectly legible imprints of vegetation with which you are familiar. But you say these specimens are not coal. So they are not: they are shales, or stones, having the impress of vegetation, and not the vegetation itself. The vegetation has become coal; but this shale, or stone, was deposited upon the vegetation, and while soft received the impression, like clay or plaster of Paris will when pressure is brought to bear upon it. You show me your photographic likeness; it is not yourself, it is an imprint of you, and not you at all. So with those specimens; but beyond this, with the aid of a good microscope, and sometimes with the naked eye, it is easy to discern in coal itself the impress of some form of vegetation. Take this piece of coal, for instance, and you will see on it the shape and impress of a cone-like substance, which I think is one of the impressions Prof. Huxley spoke of in a communication to the "Contemporary Review," of November last. This I take to be the impress of a spore-case, and when I first got it there was a very thin substance, flattened so much that looking at it end ways it was not to be seen; indeed, it was so thin and delicate that I could not preserve it. Prof. Huxley and Prof. Morris say that it is made up of those plants nearly allied to the living club mosses, and I should incline to think that future investigation will tend to confirm this.

We speak of gigantic forests, of trees immeasurably large, as being the matter out of which coal is formed. Such it may be, but my limited observation, so far, would lead in a different direction. I have an impression that we had, or rather that there was, a rich, luxuriant growth of ferns, of some 200 species, reeds, club mosses, &c. I have not a shadow of a doubt that the delicate substance I named as being on the centre of the circle in that piece of coal was the spores or seeds of the club moss. And as we know that this kind of seed is very inflammable, and used in theatres to imitate lightning, this, when fully developed, I expect will account for the presence of sulphur, in some degree, in good coal.

The trees we talk of are met with here and there, but not very frequently. No seam of coal I have seen is so interspersed with these trees as the Stanley Main seam of this district. I have in my garden fossil trees of 3 ft. 8 in. in diameter. I have not yet been so fortunate as to see one of this kind in the coal; all I have seen are just above it, in the roof, and mostly perpendicular to the strata, or very nearly so. It strikes me forcibly that if these were the trees out of which coal is formed we should not find them in that position, in such proximity to the coal seam. Nor am I at all satisfied that the stigmaria found in the floor of coal beds is the roots of those large trees called sigilaria, notwithstanding the fine specimens in the Geological Museum in Manchester.

This subject is considered the most delicate of all connected with geological investigation, on account of the time it must have taken to form so many coal seams, occupying the same area. There can be no doubt of this; but to get over it we try to pacify our consciences that there must have been something special in the formation of the coal measures; or, in other words, a miracle must have been performed in this particular division of our earth. I have no such idea. The carboniferous system must have been formed and got into its position by an unalterable law of Nature, and it is more in keeping with intelligence to frankly own that our inability to see through it rests in ourselves, and is owing to our limited capacities. Being manly enough to acknowledge so much, we shall be encouraged to toil on investigating this mysterious yet interesting subject.

III. *How the Coal came to be deep down in the Earth.*—There can be no two opinions about this division of our subject. The beds of coal, once being the surface, must have been submerged in the direction of the dip or declivity, and elevated at the opposite point, where so many seams are found coming to the surface. The covering, or shale and stone, which overlie the coal beds is what has been washed from the elavated places into that part which had become below the original level, by the very same agency that had raised its other portion above the original level. This washing is called the process of denudation, which is always going on, even now, though on a somewhat less scale than formerly. This process of elevation and depression is manifest in all coal fields, but much more striking in some than others; the most elevated being, as a matter of course, nearest the point of eruption, or centre of elevation.

We must now pass on to notice our fourth and last division.

IV. *How and why it is removed.*—Having sunk our shafts and won the coal, it is hewn out by manual labour, The precise mode of hewing would be difficult to explain in a lecture room. Suffice it to say that men have sometimes to lie down on their sides, and in other various and awkward positions. A writer in the "People's Magazine" of this month has some very strong but ignorant remarks on this subject, charging colliery owners and managers with, at the least, a degree of negligence which a class of people with very obtuse faculties only could be guilty of.

The part most important in this division of our subject is the great price to human life at which our coal is got. This is the most lamentable part of all. In the year 1869 not fewer than 1116 lives were lost in our British coal mines, besides the infliction of pain, suffering, and loss of limbs to not fewer, on a moderate calculation, than 3400 human beings, in addition to that which may be called relative suffering caused by the loss of the 1116 lives, such as widows and orphans. This cost is very heavy, and our endeavours ought to be to lessen the amount of suffering. Lessen it we have done; if not in numbers yearly, we have in comparison with the quantity of coal produced. But I am free to admit that all is not done that may and ought to be.

One of the great hindrances to lessening the number and effects of accidents is that we do not sufficiently learn from the experience of those accidents we, unfortunately, have had; or, in other words, we too commonly look upon each accident as special and peculiar to itself. Now, I cannot persuade myself that such is the case. In every accident we may find, by investigation, there is just a repetition, and nothing more, of some that have preceded it. There may be difference in degree or effects, but not in cause—that is, class and class is the same. There are various kinds of accidents, but each comes under one or other classes, and is exactly the same in kind as some that have preceded it. Yet we often say that such lives were lost by something, but how or by what means cannot be ascertained. What folly! nay, it is an untruth, in white clothing. This mysteriousness would apply more to explosions than other accidents, though by no means confined to them.

The class of accidents by which most lives are lost is that by falls of coal and roof. This is heaviest year by year, and inflicts most suffering, not only to the victims, but to the widows and orphans. There is no public subscription or outside help for these cases. All we hear of them is that the accident is owing to the man's carelessness, and the public are not sparing in attributing suicidal tendencies to the poor victim. This is merely chimerical; the collier's life is as precious to himself, and his wife and family as dear to him as most other peoples. The great thing, however, is that he is ignorant of the laws of preservation of life and health, for which he is not alone responsible. I do not use the word ignorance in its ordinary sense, but as implying the inability to perceive the altered and constantly altering condition caused by his own operations; or, in plainer words, every collier examines his working place ere he begins work, and receives his impression of the condition of it. This impression remains with him, and he toils on unconscious of the alteration made by his operations. It is this that is the prime cause of so many deaths by falls of roof and coal; and the only remedy I see for it is by increasing the number of officers in the workings, so that each working place may be visited several times during the working hours, and thus be able to get a fresh impression of their condition each visit, and to require the workmen to take steps each time to make the place safe. This carried out, I am convinced accidents by falls of roof and coal would be reduced full 50 per cent.

If coal is so costly to human life, why spend that amount of life in its production? Simply because in our state of civilisation coal is an indispensable commercial and social commodity. This is enough for a lecture itself, so that I cannot enter into all its social and commercial uses. Socially coal is of immense value. The light by which I am now reading is light from the sun which was absorded by the coal when in its vegetable condition; and not only the light simply, but the very tints of colour that might have been seen fluttering on the vegetation is reproduced, and the beautiful mauve and

other loveable colours are obtained from coal. The "Chemica. News" of February 3 last informs us that coal-tar colours may be counted by the dozen. So that the bewitchingly beautiful colours upon the still more beautiful heads of our ladies may be looked upon as the production of our coal pits. Now, do not think any the less of them after being told they come out of such a dirty place; rather let it enhance your estimation of the workers in coal mines.

Another important social use is the house fire, before which anger is melted into love, cold harsh tempers made warm and soft, family quarrels settled, and new joys created. So dearly is the social fire prized, that should you enter a friend's house, and not be invited to sit by the fire, you would consider yourself insulted, and be disinclined to go there again. The proudest moment in the life of a young lady is when, as a newly-made wife, she is able to say she has got a "fireside of her own."

The commercial uses of coal are so many and important that without it England would not be a commercial country at all. It is used for smelting the precious metals gold and silver, copper, tin, lead, iron, &c. But its greatest achievement is in converting water into steam. Imagine the locomotive engine to leave Leeds at 9·47 and reach London at 2·45 o'clock, in spite of wind or weather. See the majestic vessel steering against wind and tide, defying the elements. What chance has the poor sailing ship with a steamer such as is now built? The former must wait for weather and favourable winds; the latter is timed, and must leave and arrive at specified times, in spite of adverse elements.

One other aspect, and I have done. In the production of coal there are not fewer than 345,446 male persons employed, finding the means of sustenance for fully 1,727,230 persons, besides the numbers that are employed in its transit and consumption. Surely an industry that affords the means of sustenance for a twentieth part of our population is one that cannot be looked upon as insignificant, but of some importance, contributing to the comfort and well-being of our social life, and the aggrandisement of our country in the eyes of the whole world.

Long may our country stand first in its production of so indispensable a commodity. Soon may we learn to produce it at a less cost of human life and suffering. Thus less gloomy shall we enjoy the social benefits it confers.

BREAKING DOWN COAL.

SIR,—I read in the article on the Mineral Resources of Nova Scotia, published in last week's Journal, that at the Albion Mines a mechanical application of force in lieu of blasting with gunpowder had been introduced, which consists of a series of wedges driven into the coal by hydaulic pressure, by which the coal is rent and lifted out of its place, so that it is easily broken up into suitable sizes for filling into the tub. Such an apparatus as this seems exactly to correspond with those of Messrs. Bidder and Jones; so exactly, indeed, that I presume it is really the invention of one or other of those gentlemen that has been adopted. If this be so, it would be most interesting to know what amount of success has attended its use, for I think it is much more likely to be fairly tried in Canada than at home. In the new world there is a decided liking for novelties, and especially for labour-saving machines, whilst at home the feeling is rather of the opposite character; so that if a machine can by any means be made to work well it is there sure to be driven to a success, whilst in Great Britain many inventions having all the elements of success are suffered to become failures.

No doubt the wedging system has been sufficiently tested at the Albion mines to permit of the particulars being given as to the results obtained by (say) one party of men in three months' working, as compared with those obtained by a similar party engaged on similar work for the same length of time. The value of such information would be almost inestimable, for it would enable those at home, both colliers and coalowners, to judge of the practicability of dispensing with gunpowder for getting down coal. If the Canadian colliers can do as much work with the wedges as with gunpowder, there is no reason why English colliers should not do the same; but if upon three months' working there is shown a loss to the men, it is unreasonable to expect them to submit to the prohibition of gunpowder to assist them with their work, unless they are offered additional wages by way of compensation. It would be most interesting if some one connected with the General Mining Company would state how many tons of coal per month (of course, all the circumstances being as nearly as possible) a couple of men can get with wedges and with gunpowder, respectively, and which system of working gets the coal in the best condition for market. PHILOS.

March 28.

ORE DRESSING—No. II.

SIR,—HAND SEPARATION.—This operation, although often considered as simply preliminary, is really of great importance, and the way in which it is carried out has a great deal to do with the profitableness of the whole after dressing. In order to make it really efficient it should be began underground by the miners themselves. All miners working on orey ground should be instructed to pick out and pile up separately the very pure ore and the mixed rocks; it is much easier for them to do so when the fractures, from the breaking down, are still clean than it would be above ground, when the whole mass has been mixed up together, and is, as in generally the case, covered with dirt and mud. The clean, or "rock," ore, which would be kept separate, would require another examination above ground, and all lumps that are at all of a doubtful character should be broken opened and examined, and as much gangue as possible be removed by hand hammers.

All the remaining mine stuff as it comes from the pit should be tipped over a screen, with the bars set about 3 to 3½ in. apart. The large stuff resulting from this screening should then all be hand picked and separated, and as much as possible taken out for "rock ore." Where labour is very high it is, perhaps, better to run this large stuff through a stone-breaker, and have it picked by hand, though there is more loss in this process, by the formation of fine dusts, than where the hand hammer is used.

All the fine stuff resulting from the screening is then best subjected to a thorough washing, to free it from all earthy matters, previous to its being also hand picked. About the best and cheapest way of doing this is to dump it on to a second set of grate bars, with openings (say) of ½ in. A strong stream of water being turned on, the whole mass is well raked about on the grate till cleaned, and then passed on to a picking-table. The finer stuff which passes through these latter grates may be caught either in wheel-barrows placed below, or better be at once raised by an elevator to the sizing machines. All that is thrown on the picking-tables, either from the washing screens or from the stone-breaker, should be sorted by hand into at least three classes—rock ores, lean ores, and tailings. The first class, of course, receive no further manipulation, but are ready for the smelter; the lean ores, or rather the *mixed* ores, being those which are further treated.

In most parts of England and America the price of labour is far too high to permit of such an elaborate system of hand picking, but wherever it can be applied it is found that a very great saving is made by doing so, not only by largely facilitating the remaining dressing operations, but also in the net yield of ore, and in the higher percentages obtained. In Germany and Belgium, where boys and girls are generally employed for this operation, at wages varying from 8d. to 1s. per day, it is found that the whole cost of hand separation does not exceed 1s. 3d. per ton of finished ore. In England this operation often costs from 2s. to 2s. 6d. per ton. The best kind of picking-table is made circular, and movable on a central pinion. The surface should be slightly raised towards the centre, from whence the ores are fed. The diameter of such a table should be 6 to 8 feet. The children stand round it, and as it revolves slowly pick out all the tailings and rock ores they can; the great mass of stuff being swept off by a movable rake, after having made one entire revolution of the table. Each child is provided with a little rake, to turn over the ores as they pass him.

CRUSHING.—The next operation, and the one which in most mines occupies the first place, is the crushing. A very great deal more depends on the manner in which this is carried out than many miners imagine or care about. The whole proportionate amounts of high and low grade ores are determined by the manner in which they have been pulverised, and an ore ought to be well known and its constituent parts well studied before the system of crushing which would be the most economical can be determined on.

The aim of the miner in crushing should be not to convert the whole mass into powder, as is unhappily too often the case, but to split the ore as much as possible according to its cleavage, and *no smaller* than is absolutely necessary to separate the different constituent parts. Crushing, being always the most expensive part of the whole operation of dressing, should be economised as much as possible, and, of course, the larger the ore is kept the less will be the cost of crushing. So much is this a fact, indeed, that I have in many instances found it cheaper to crush first the whole mass to a size much larger than would permit of a definite separation, concentrate the same (by which means generally 35 per cent. of the tailings have been separated), and then re-crush the remainder for further concentration, rather than reduce the whole mass at once to the required size. Another advantage in crushing by degrees to a fine size is the fact that a great saving is thereby produced of the fine slimes, which are, as a general rule, very intractable when once formed, and occasion a great loss of the richer ores, it being a well-known fact that the purer the ore is the more easily it is pulverised.

There are three systems of crushers, which may be classed according to the amount of slimes they produce in crushing the same quality of mineral to a given size.

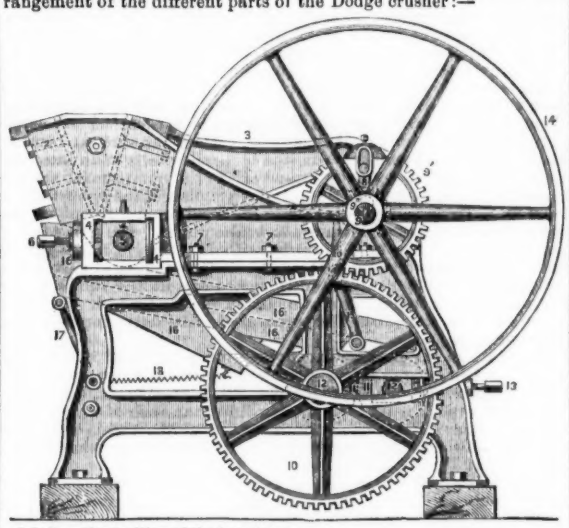
1.—The jaw-crushers or stone-breakers, which produce the least dust.

2.—The Cornish rolls, producing generally from 15 to 18 per cent. more dust than the jaw-crushers.

3.—The stamps, which show an increase of from 25 to 30 per cent. of fine dust above the Cornish rolls.

Crushing by the jaw-crushers can scarcely be considered more than a preliminary operation previous to the real crushing by rolls or stamps, though in Prussia there are some small machines of this description made, which reduce the ores to grains of about three-eighths of an inch diameter. As an auxiliary to the rolls and stamps these stone-breakers are really invaluable. The manner in which they have been introduced everywhere since they were patented is really surprising, considering the difficulty there generally is in introducing any new machine for ore dressing, and is proof enough of their efficacy. The amount of work one of these machines will get through is really enormous. One of Blake's medium size will easily keep two pair of rolls at work. One great advantage in these machines is, as stated above, the very small amount of dust they produce in breaking up the ore. It has been estimated, and I have myself found by experience, that a saving of nearly 40 per cent. of fine stuff and dust is made when the material to be crushed has first been broken up by these jaw-crushers.

There are two patents out for these stone-breakers—the Blake and the Dodge. The former is too well known to require any explanation here, especially after the notice on them which lately appeared in your columns. The Dodge crusher is, in reality, a combination of a jaw-crusher and rolls at the same time, though the one part can be had independent of the other. The manner of giving motion to the jaws is rather different to the Blake, and purports to be stronger and less liable to breakage than the latter. It is coming a good deal into notice, and seems to give satisfaction. One of its great advantages is its extreme lightness and consequent cheapness—the expense of a Blake's crusher being a great drawback to its adoption in many mines. The following sketch will explain the disposition and arrangement of the different parts of the Dodge crusher:—



1·1 show the position of the jaw plates.
2·2.—Bolts by which the plates (1) are held in position. [eccentric (8).
3.—Lever by which the crushing is effected, being raised and lowered by the
4.—Box in which the fulcrum (5) of the lever (3) moves, which is adjustable horizontally by the set screw (6) and the washer or plates (4¹). [stand.
7.—Bolts by which the upper part or crusher is fastened to the lower part or
9.—Shaft which carries eccentric (8) and pinion (9¹), ratchet-wheels, fly-wheel,
8.—Eccentric. [and driving pulleys.
10.—Spur-wheel driven by pinion (9¹), keyed to shaft (12) of roller (11). The other roller (11¹) being moved by gearing on opposite side. The shaft (12¹) is in a box adjustable by set screw (13), there being also a rubber-buffer (19), backed with cast-iron washer between this box and the set screw (13).
15.—Ratchet lever, giving shaking motion to sieve (16), &c.
16.—Shaking-table and sieve, for the purpose of separating the fine stuff from the jaws, and thus relieving the rolls from the work of taking it through again.
17.—Lever which supports the shaking-table under the jaw.

New York, March 7. E. G. SPILSBURY, Civil and Mining Engineer.

TEN MINUTES IN THE PARIS BOURSE.

SIR,—As an old contributor to your columns I trust no apology is necessary in proposing to give you from time to time a few sketches suitable for the Journal, of subjects which have come under my observation since I left England, and while travelling through Europe, and the more vast, and to me more interesting, continent of America. The first of the series I propose to put under the above heading.

In accordance with my natural tendency to violent transitions, I make it a rule, while abroad, whenever it is practicable to do so, to witness in quick succession the great opposite extremes. I drove through the Bois de Boulogne, and decended the Catacombs on the same day, for precisely the same reason. In the former I encountered Parisians, gay, dashing, superb, hilarious, *above ground;* in the latter I saw the disjointed skeletons of their fathers and kindred, assorted and shelved like the wares of a merchant, in a grim, awful, ghastly cavern of the dead.

My visit to LA BOURSE was a scarcely less striking transition from the crypts of the Pantheon. In the latter I had examined the tombs of Mirabeau, Marat, Voltaire, and Rosseau, and been well-nigh deafened by the thundering, and very remarkable echoes of the place, sounding as if the immense structure was being battered to its base by successive volleys of artillery. In the former I was about to hear, not the dead sounds of subterranean masonry, but as it afterwards seemed to me, the echoes of the infernal regions themselves.

The Paris Bourse is situated, as, doubtless, many of your readers know, in the very heart of the city, and occupies an entire square, with streets on its four sides, the edifice itself being surrounded by a colonnade of 66 Corinthian pillars, its western front presenting a very imposing appearance, as approached from Rue Vivienne. The area of this structure is 212 ft. by 126 ft., and its front corners are embellished by statues representing Industry, Agriculture, Commerce, and Navigation. The time of commencing business at this institution is 12 o'clock; its hour of adjournment, 3 P.M.; and as I had learned that its most appalling climax was usually reached at 1·30, I directed my driver to land me there at that hour, and at which I punctually arrived. The street in front was densely thronged with vehicles, and for a few minutes I kept my seat in the open *voiture de place*, surveying the stately edifice, and the excited crowd of at least 1000 persons that surged beneath the western portico. I was full 50 paces from the entrance, but the sound that issued from within was quite audible, and suggested the "rushing mighty wind," employed as a figure to describe the advent of the spirit's power on the day of Pentecost, not doubting, however, that the noise I heard was caused by a very different spirit. I alighted, and ascended the steps, passed through the outer throng, and entered the portals of the far-famed Exchange. I was not an altogether inexperienced observer, having previously attended the Exchanges of London and Hamburg, witnessed the exhibitions in the New York Gold Room, and heard the howlings of the Wall-street "bulls" and "bears;" but all these were like the cooing of doves compared to the acoustic diabolism into which I was now to be initiated. As I entered the sound grew more violent; and when I got fairly within, the scene was indescribable. I will not pretend to set down what took place, as the entire medley of incoherent sounds, unintelligibly uttered, were to me the veriest gibberish imaginable. I will only transcribe, as best I can, the never-to-be-forgotten impression made upon my mind.

The sound of the thousand voices which fell upon my ear, all pitched at a key of infuriated avarice, might, with one's eyes closed, have suggested the raging fury that rends in shivers the rigging of a ship in a hurricane at sea, or the awful mutterings that accompany an earthquake, or precede the eruption of a volcano, or the submerged moanings that issue from the inexplorable caverns of the deep, or the peals of anguish and despair that tear the hearts of a ship's passengers about to take their death-leap from a burning vessel. I say that to a blind observer this vocal medley might have resembled all of these sounds, or any others outside of heaven, but it was, probably, not exactly like any other thing on earth. The money-hungering chaunt of the Paris Bourse is *sui generis*, and can only find its parallel within itself. Hundreds of spectators were witnessing the mad scene from the galleries above, and it occurred to me they were wise in keeping at so safe a distance. I felt myself on the ground-floor like a lamb in a menagerie, and instinctively instituted a closer vigilance over my pocket-book. There were around me at least a thousand active participants in the business of the hour, and in the dark no living soul would have imagined that their deafening clamour proceeded from human lungs. The faces of these men were to me a deeper and more significant study than the pictures in the Louvre, or the relics in the Cluny. Here was Paris in a nutshell—the financial princes of the queen city of the whole earth, besotted, maddened, blighted to moral blindness by "the root of all evil"—the love of money. Every person in the room appeared to be screaming his utmost, and gesticulating threats of immediate homicide to the man he was speaking to. On a platform, raised some 18 inches above the floor, and occupying a large space in the centre of the room, there were more than a hundred men, who, from some reason, seemed to monopolise a special privilege. These men ran to and fro, yelling like so many fiends, beating the air with their uplifted hands, with the perspiration coming from and trickling down their anxious faces and bald heads. There was hardly a man among them who had passed his fortieth year, and yet there was not one good head of air—most of them were as bald as a polished pumpkin. Hair, I concluded, soon burns out with such a furnace at its roots.

But the grand climax is not yet attained. At the extreme end of the room, divided from the rest by a slight but strong railing, were some two hundred others, whose prerogative it was to do the bawling and howling, *par excellence*, and here the bedlam of tongues was still more frightful. Right in their front the fury raged, as if the lower regions had suddenly been deserted—as if, in fact, a very host of "rich men" had come up from their sulphurous den to make a raid on the Abrahams inside the railing. I observed in this part of the room that the men's eyes protruded from their sockets; that their expression of countenance was more frantic, and their gestures more vehement. Here comes three fellows rushing through the crowd, looking like madmen. Rapid locomotion is, of course, impossible, and their faces look as if their eager souls were bent upon making a certain point at the peril of losing their bodies. They have evidently just been executing orders with limited time, and must see their principals instantly, or lose their commissions.

The entire spectacle here presented (considering that the actors are not starving beggars, but men of wealth; that they are not untutored savages, but leaders of the world's etiquette and refinement)*is the most sickening commentary upon what we call "advanced civilisation" that I have ever witnessed. The very sight of it robs one's nerves of electric force, and after enduring the scene for 10 minutes, I made my way out, as if escaping from torture.

In the comparative quiet of the street the recollection of the Catacombs, with their myriads of human bones laid quietly at rest, was an agreeable relief; and it occurred to me that to the members of the Paris Bourse this subterranean receptacle of the dead ought to be "a consummation devoutly to be wished." E. H. WADGE, F.G.S.

New York, March 8.

ANTIMONY PAINT.

SIR,—Will some reader kindly inform me, through your valuable Journal, the process of making antimony paint (white paint), and what dryers are generally employed, and if this paint is much in use in England, and what is its market value? I never see it mentioned among the other metals in the *Mining Journal*. Is it made from the oxide or sulphurate, or both? I would like to see prices quoted of antimony ores, oxide, and sulphurate, and also the regulus: it would be a guide to us in this far-off land.

The interesting descriptions which you give of large mining and iron manufacturing establishments in England and on the Continent are read with much interest here. We noted with pleasure your account of the Govan Ironworks, in the Supplement to the Journal of Oct. 22. There is a fine field for your correspondents in Glasgow and on the banks of the Clyde, and I am certain that their sketches will be very acceptable, more particularly to those of us who have been so long away. JOHN FINNIE.

Ringwood, Box-hill, Victoria, Australia, Jan. 30.

GLEANINGS FROM MINING PROGRESS.

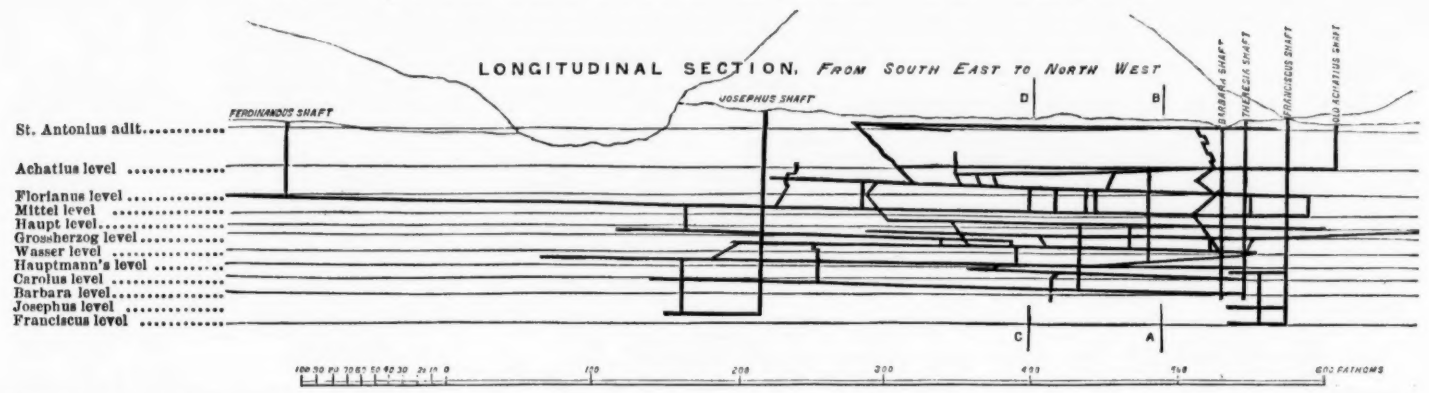
SIR,—In a business country like this details of industrial operations make up the sum of its prosperous enterprise. To many it would seem of little moment to discuss the nature and tendencies of budding products in a great field of enterprise; but be it known that it is by the germ and the tendril that the value of a soil is recognised, the culture indicated and the estimate of the harvest made the measure of the garner into which it must be gathered. Thus with mining it serves as a beacon and guide to enumerate from time to time the successes of this, that, or the other centre of mining industry. In a word, it teaches by fact—that great logical teacher of truth—the common-sense science of chosing a mining or mineralogical centre in the radius of which it would be wise and safe to venture upon an outlay of capital. Now, for a general, a public benefit permit me to quote the following incidents which mark the ore-bearing *status* of certain districts. In *primo*, take the Van district, of which the Van Mine is the central mark; this lead circle is giving daily proofs of the vastness and availability of its richness in mineral products. The Van Mine is at present yielding lead to the extent of 500 tons per month, and it is scientifically represented that with a moderate increase of machine power the returns can be increased to 800 tons per month, while computing from its present progress through highly charged ground the mineral reserves will be as valuable as they are considerable.

Well, looking at this picture, veracious in every feature, and that which I shall exhibit, it will be proved that British mining has within it a valuable existence, that cannot easily be stamped out—in fine, an endurance that is in value far beyond the present human power of computation. Only about two years since the Van Mine was sold for 46,000*l.*, and the shares, upon their intrinsic value, have had a realisable standard of 1,000,000*l.* Now, as in rays of light, so in successful mining, every point has its radiation; and, therefore, as experienced men indicated, other enterprises have started into existence. Aberdaunant, for instance, has shown in prolific promise above the surface, a result not to be much wondered at, no doubt, for it is working on the same lodes as the Van, exhibits a similarity of strata and products, and has sent to surface ore of no less stand ard value, which has been continuously sent to market. Independent of that, the operations recently have been distinguished by such

discoveries and indications that scientific miners look forward to good results; and if one particularly anticipated be achieved, this mine will, speaking moderately, be only second to the Van. As a lead mine there are few among progressive mines more valuable than the Aberdaunant. The Plynlimmon and the Tankerville are also striking up in formidable promise among the rising generation of British mines, and will yet grow into prominence on the market.

Writing *currente calamo*, I have to pass over some regions of good ground without mention at the present moment; but I cannot without injustice omit a glance at East Llangynog, another child of a great centre—the celebrated Llangynog Mine. The discoveries in East Llangynog have been for some time so stable and productive that it will be enabled to send 50 tons of lead to market almost immediately, and this is only counting a working period of four months from the formation of the company. There can be no doubt of this sterling fact; and the something beyond indications—that is to say, all but actual certainties—show that the quantities must, through the scientific operations so steadily carried on, be not only augmented but continuous, and will shortly place the East Llangynog Mine in a substantial and long existing position on your Dividend List.—85, *Gracechurch-street, March* 28. J. P. ENDEAN.

THE QUICKSILVER MINES OF IDRIA.



MINES AND MINING—No. II.

SIR,—The Idrian quicksilver mining sett has an area of 228·07 square acres, upon which five shafts are sunk, and two adits and eleven levels driven. Thus is the mercuriferous deposit opened by levels 800 fms. to the strike, 300 fms. on the width by cross-cuttings to the top and footwall, and with shafts to a depth of 145 fms. In the direction of the strike from S.E. to S.W. are the following shafts located:—

1.—The Ferdinandus, 55·6 fms. deep beneath the horizontal line of the St. Antonius adit.

2.—The Josephus, 135·0 fms. deep beneath the horizontal line of the St. Antonius adit, 355 fms. N.W. of the former.

3.—The Barbara, 122·3 fms. deep beneath the horizontal line of the St. Antonius adit, 315 fms. N.W. from Josephus shaft.

4.—The Theresia, 128·0 fms. deep beneath the horizontal line of the St. Antonius adit, 340 fms. distant from the Josephus shaft.

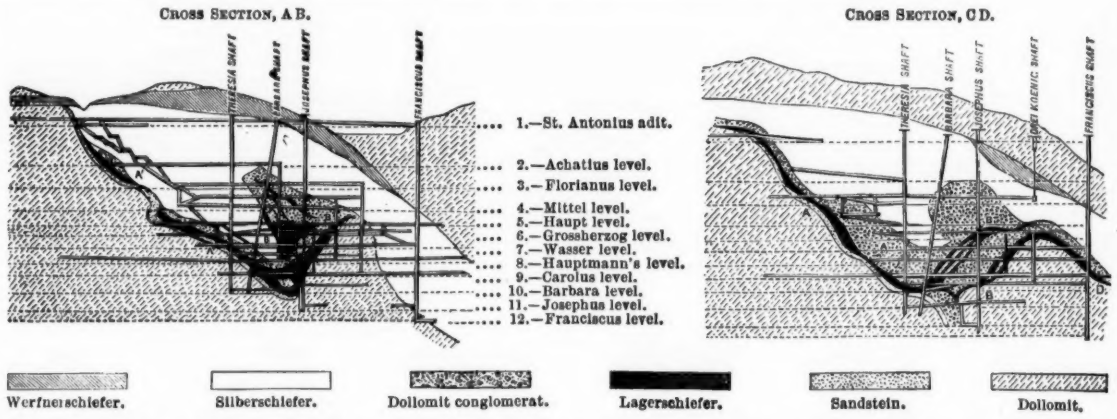
5.—The Franciscus, 146·5 fms. deep beneath the horizontal line of the St. Antonius adit, 130 fms. north of the Theresia shaft.

The adits are:—1. The Florianus, driven from the Franciscus shaft in a N.E. direction, the mouth of which is situated 507 fms. distant from the said shaft, near the bed of the River Idriza; it drains that part of the mine, and takes the used water from the turbine-wheel, which is erected on the same level, near the shaft. From the Franciscus shaft is an end of the adit, at work in a S.W. direction, to ascertain the continuation of the mercuriferous deposit; another branch of it has to communicate with the Theresia shaft, to convey the water of the turbine-wheel of the said shaft.

2.—The St. Antonius. The highest of the levels is 757 fms. long, of which length about 270 fms. are driven on the strike of the deposit, the remainder being cross-cuts to the hanging and lying walls. The mouth of this adit is situated nearly in the centre of the town, about 60 fms. S.W. of the Theresia shaft, 1074 ft. above the Adriatic Sea. This adit is the main road for all the workmen to the mine, and communicates in 85 fms. south of the mouth, through inclined shoots, with the lower workings. The shoots have an inclination of about 20° to 25°, and are put in with elliptical stone walling and stone steps; they have the local name, "rollen." The first five shoots, named Athems rollen, lead to the 1st level, the Achatius feld, 33 fms. beneath the St. Antonius adit, from where two other shoots, the Heitz feld rollen, communicate with the 2d level, 49 fms. below the adit, termed the Florianus feld. The shoot Kœmpfische rolle connects the 2d level with a 13 fm. deeper level, the Mittel feld. Through the two Kœffler rollen shoots can be reached the 4th level, Haupt feld, 74 fms. under the adit, and the 6th level, Wasser feld, 17 fms. below the level Haupt feld. Between the Haupt and Wesser feld, 9 fms. higher than the latter, is the Grossherzog feld, the 5th level. Below the 6th level, Wasser feld, are—the 7th level, Hauptmann's feld, 103 fms. below the St. Antonius adit; the 8th, Carolus feld, 110 fms. below the St. Antonius adit; the 9th level, Barbara feld, 120 fms. below the St. Antonius adit; the 10th level, Josephus feld, 132 fms. below the St. Antonius adit; the 11th level, Franciscus feld, 142 fms. below the St. Antonius adit. All the eleven levels communicate with one or more of the five shafts, and with several vertical sinks and inclined shoots, which facilitate conveyance and the ventilation of the mine.

The levels or main roads are driven out near the underlie of the "Lagerschiefer," in a parallel line to the head strike of the deposit, and are, through short cross-cuts, connected with the shafts. From the levels run cross-cuttings to the top and foot walls; the former cut the oreyiferous lagerschiefer (*a*), the zinnabar-impregnated dolomite conglomerates (*a*), the two ascending branches of the lagerschiefer (*b* and *d*), and the descending part of the said (*d*), with the overlied mercuriferous dolomite conglomerates, until they terminate in the Silberschiefer (silver schist); the latter are driven through the sandstone in the underlying magnesian limestone, as shown in the section (*A B* and *C D*). The mercuriferous minerals are worked out by the system used for working large lodes on the Continent, called "Querban." Commencing from the main roads, the mineral is cut away on both sides of the before-hand driven cross-cuttings, 6 ft. high and 6 ft. broad, before each face being two men. When they advance about 2 fms. from the main road two other cores commence to work out the ground on both sides behind the first two cores, then follows the third core, &c., in proportion to the advance of the workings. The roof is supported with door-posts (durnoes), and the attle is carefully piled up between them. In this manner the first floor of the deposit is worked away, the roof supported with timbering, and the goafs filled up with attle. To commence the higher floor (etage), winzes are stoped right over the cross-cuttings near the main road, and from them the ore is stoped in the manner as before said. When the second floor is worked out the third is to be commenced, and so on till the upper level is reached. The ore won in the higher floors is brought in small four-wheeled wagons (hund) to the shoots. The miners are paid per cubic fathom solid mass of rock cut out, including timbering, picking the ore, and carriage to the shoots, from 12*s.* to 21*.* They have, besides the cutting of the ground, as well to put up the durnoes (generally three to a current fathom), to pick out the rich from the poor ore, to throw the attle behind in the goafs, and to carry the ore from the workings to the shoots. A miner cuts, on an average, in a shift of eight hours, about 13·3 cwts. of mineral, from which 10·9 cwts. of ore and 2·7 cwts. of attle are obtained. The cost of cutting amounts to 1*s.* 3*d.* per 1 cwt. of mineral, or 0·76*d.* per 1 lb. of mercury produced. The percentage of attle, being only 18 per cent. of the broken mass, is not sufficient to fill up the goafs. The other 82 per cent. of attle necessary for supporting the roofs is obtained from drivings and sinkings through dead ground, and is carried by a separate core of men, named Bergversetzer, to the workings, which is always done by another shift to that of the miners at work: 1 cubic fathom of attle piled up in the workings, including carriage to them, costs from 4*s.* to 6*s.* From the shoots the ore is taken away in wagons over the tramroad through the levels to the shaft by a separate core of men, termed Hundstosser. The levels where the sides are worked away and where they run through soft ground are arched in with stone. By the shaft the wagons are emptied into kibbles, and the ore is raised in them through the shaft to grass.

The shafts are of a rectangular section, 16 ft. by 7 ft., and perpendicular, except the inclined Barbara shaft, and have all a strong collar timbering. They have three divisions—one for hauling, one for pumping, and one for the men to descend and ascend by ladders,



each being divided from the other by brattices. The old timbering of the Josephus shaft is now to be replaced by a new one, with guides, for raising the mineral in cages. As the Idriza river gives a constant supply of water all the year round, the machines intended for raising the mineral and for pumping the water out of the mine are mostly constructed for the use of water-power:—

1.—At the Theresia shaft a horizontal turbine-wheel, with two rings of buckets, curved in opposite directions, each having two sluice-boxes, serves for the raising of ore. The water is admitted on the circumference of the wheel in two diametrical jets in a tangential direction to the curves of the wheel. The whole wheel is constructed of cast-iron, with curves of sheet-iron. From the vertical turbine wheel-shaft the power is transmitted by bevil-wheels to an intermediate shaft, and from this by cog-wheels to the whim-shaft. On the whim-shaft two cylindrical rope-drums are placed, the one which is loose on the axle being connected to the fixed drum with bolts. On the circumference of the drum the brake works. The ropes is use are wire-ropes. The turbine works with 11 effective horse-power, and raises a load of about 1 ton. For water-pumping an overshot water-wheel, of 37½ ft. diameter, is erected to work the pumps, and a 60-horse power condensing steam-engine, on the Cornish system, is kept in reserve, if needed. The pumps are double-acting force-pumps, with solid plungers.

2.—Through the Barbara shaft the mineral is raised by a water-whim. On the same shaft with the rope-drums the overshot water-wheel is fixed, the circumference of which is provided with two systems of buckets, opening in opposite directions, each of which has a separate sluice. The diameter of the wheel is 32 ft., and is composed entirely of wood. The pumps are worked by an overshot water-wheel, of 19 ft radius.

3.—The vertical turbine-wheel which draws the mineral through the Franciscus shaft is situated about 9 fms. underground in the horizont of the Floranius level, 10 fms. distant from the shaft. The wheel has only one ring of buckets on its periphery, and the water is brought through the shaft down in iron pipes to the mouth of the sluice. A single jet of water is admitted to the circumference of the wheel, tangential to the curve of the buckets. On the shaft of the turbine-wheel a pulley is fixed, which transmits the power by a wire-rope to a second pulley, fixed near the shaft in the horizont of the adit. Another pair of pulleys transmit the power by wire-ropes to the shaft, upon which two bevil-wheels are fixed, so that they are from each other somewhat more distant than the diameter of the mitre-wheel upon the shaft, on which a pinion is placed, gearing into a wheel, fixed on the rope-drum shaft. The brake works on the circumference of the drum. From the two bevil-wheels one or the other can be brought in connection with the mitre-wheel, and so gives to the drum-shaft forward and backward motion. The turbine works with an effect of 9-horse power.

4.—At the Josephus shaft is a 24-horse power horizontal, direct-acting, high-pressure engine, with two cylinders, newly erected, for raising the ore. The pumps are worked by an overshot water-wheel, 42 ft. in diameter.

5.—A 45-ft. overshot water-wheel at the Ferdinandus shaft serves for winding and pumping.

In the year 1868 the output of mineral was 27,230 tons, containing 10,308·54 cwts. of mercury, and it is from year to year rapidly increasing. In the mine the ore is separated by the miners into three classes:—1, rich ore (reiches erz); 2, poor ore (scheiderz); 3, waste or attle thrown in the goafs. The former two are brought in tramway wagons from the shoots to the shaft, and each class of ore is raised separately in kibbles to the bank of the shaft. The kibbles are made of strong sheet-iron, and hold from 18 to 20 cwts. of ore. Below the bank on the long side of the shaft is an inclined shoot, which is divided by a rectangular coarse sieve into two divisions. The kibbles empty the ore into this shoot on the sieve; the smaller falling through, while the coarse ore remains on it. From the shoot the ore is brought on a tramroad in wagons to the reduction-works. A, the rich ore, is taken to a separate dressing-place, where it is thrown over smaller sieves, and divided into two classes:—1, rich fine ore; 2, rich coarse ore. The rich fine ore contains from 10 to 20 per cent. of mercury, and is sent to the distilling-works. The rich coarse ore is picked by hand, and divided into three classes:—1, very rich ore, containing from 30 to 60 per cent. mercury; 2, rich ore, containing 15 to 30 per cent. mercury; 3, middle ore, containing from 5 to 15 per cent. mercury. B, the poor ores, having from 1 to 3 per cent. of mercury are, by the shaft on the coarse sieve, freed of the very coarse ore (wœnde), which is brought on the floor of the reduction-works, to be broken to a smaller size and picked before being sent to the distilling works. The ore that falls through the sieve (scheidgut) is thrown over a series of two rectangular sieves, fixed one below the other, each with a separate shoot for receiving the classified stuff, which is classed into three sizes:—1, coarse poor ore, (stufen); 2, middle poor ore (graupen); 3, fine poor ore (gries). The coarse and middle poor ore is brought on picking-tables, and there the rich pieces and the rubbish picked out; the remainder is loaded into wagons, and taken to the distilling-works. The fine ore is filled into wagons direct from the shoot, and sent to the mercury distilling-works.—*Przibram, March* 14. A. PLAMINEK.

ON THE DRESSING OF ORES—No. IV.

CRUSHING AND GRINDING MILLS.

SIR,—When ore is freely intermixed with veinstone the isolation of one from the other is commonly effected by crushing the stone, bringing particles of like size together, and subjecting the classified products to the action of jigging machines, or to other suitable enriching apparatus. Long experience has demonstrated the fact that the difficulty of concentrating ore increases with its fineness, consequently it is of great importance to secure the metalliferous grains as near to their normal dimensions as is possible. Whatever practical care may be employed for this purpose it can be only partially attained, nevertheless a considerable loss in castaways, as well as unnecessary expense in dressing, may sometimes be avoided by properly adjusting the pressure on the rolls, and permitting the crushed stuff to go direct to sizing trommels.

In our Cornish mills the "fine" riddle and raff-wheel arrangement produces a kind of continuous crushing, the "roughs" larger than the griddle spaces being again and again returned to the rolls. In soft copper and lead ore associated with hard quartz and slate, the result is an unnecessary proportion of fine ore and clay, which, in water, too frequently forms a viscid objectionable slime. In continental mills the raff-wheel and riddle seldom form an accessory to the rolls. The general practice is to maintain the faces of the latter in good condition, and to pass the crushed stuff direct to the sizing trommels, sending only such portion as cannot be jigged either to the first or to a second crusher. Except for the purpose of crushing earthy varieties of coal the German crusher is for the same diameter usually much shorter on the face than those used in this country, in fact the width of the roll seems to be decreased in an arbitrary proportion with the hardness and cutting nature of the stuff. In addition, the mill is distinguished by a fly-wheel to overcome any irregularity of motion. For crushing fine stuff a feed roller is frequently geared in connection with the crushing rolls, and the latter are always kept to their work by means of adjustable springs. Disc springs, consisting of alternate plates of caoutchouc and iron, have altogether superseded the lever and weight. Rolls subject to the former arrangement merely open sufficiently wide to allow hard foreign substances to pass, but under the dead weight system hard resisting material is apt to jerk the levers, and to carry the rolls further apart than is necessary, thus, with a long irregular line of roller contact uncrushed stuff must freely pass to the revolving riddle, raised, and re-passed until broken, so as to escape through the meshes of the latter. The mode of gearing the roll to the axle is also different in Germany to our English practice. A thick cylinder is truly centred on a wrought-iron shaft, and on the outer surface of this cylinder, which is slightly taper, the crusher shell is securely fixed by means of three bolts and nuts.

Fig. 1.

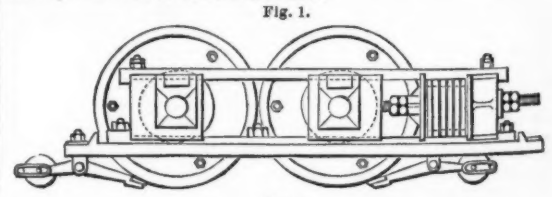
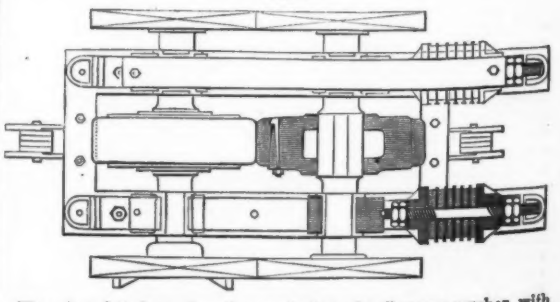


Fig. 2.



Figs. 1 and 2 show elevation and plan of a German crusher, with caoutchouc and iron disc springs, the scrapers under the rolls, adjustable weights, as well as the method of fixing the rolls already referred to. In the plan two sets of driving wheels are shown, one

on each side of the frame. This driving arrangement is not, however, in general use.

Fig. 3.

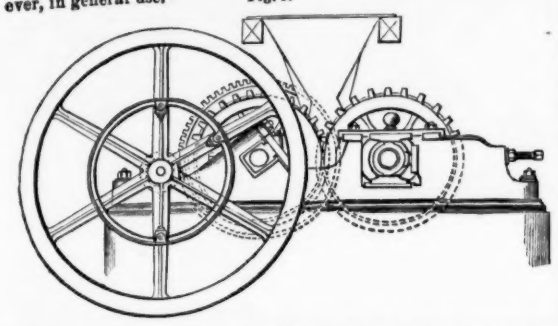


Fig. 3 exhibits a mill constructed by Messrs. Huet and Geyler. The driving rigger, fly-wheel, pinion, and follower are set outside the frame, the two spur-wheels are fixed within the frame, close to the ends of the rollers. The spring for producing compression between the rollers are placed within cylindrical boxes, greater or less elasticity being given to the rubber by means of set screws. The rolls of French mills are from 8 in. to 45 in. in diameter, length on face from 8 to 12 in. In Germany the length of rolls for crushing metalliferous ore is usually 10 in. long, and from 10 in. to 36 in. in diameter. For the purpose of crushing shaley coals the length varies from 20 in. to 30 in.

Now that the use of stone-breakers renders it unnecessary to employ rolls of very large dimensions, coarse jigger work may be advantageously obtained with rolls from 18 to 30 in. diameter, and fine jigger work from rolls 18 to 10 in. diameter. Both coarse and fine sand jigger stuff cannot be strictly defined; it will naturally vary with the normal condition of the ore and its associated mineral, as well as with the relative density of each, but it will be sufficiently near for practical purposes to regard stuff ranging in size from 10 to 12 milimetres as coarse jigger work, and sand from 2 milimeters to ¼ milimetre as fine jigger work.

The cost of reducing a ton of stuff to a specific size must depend on a number of conditions, such as cost and hardness of rolls, charges incident to wear and tear of machinery, cost of power, value of labour, structure of the stuff to be crushed, and arrangement of the mill itself. Hard well-proportioned rolls should always be employed, even if moderate economical results are to be obtained. In Germany steel rings have been found to give excellent wear, but the cost of fixing and turning the rings has to a great extent precluded their use. The circumferential speed of rolls in German mills is from 90 to 180 ft. per minute. Variable speeds have been tried in order to produce friction, together with pressure at the line of contact, but it has been found that any departure from a uniform speed in the two surfaces absorbs a considerable amount of power without materially augmenting the results. Rollers worked by friction furnish less economical results than those driven by spur gearing.

The following particulars are given in connection with a Cornish crusher operating on steel-grained lead ore, associated with carbonate of iron, quartz, and hard grauwacke:—Diameter of rolls, 21 in.; length on face of rolls, 19 in.; weight of new pair of rolls, 2700 lbs.; weight of worn-out pair of rolls, 1600 lbs.; number of revolutions of rolls per minute, 8; speed on face of rolls per minute, 42 ft.; size of stuff before entering rolls, 20 milimetres to 60 milimetres; size of stuff after leaving rolls, 6 milimetres to 0; weight crushed per hour, 2½ tons; quantity of stuff crushed by a pair of rolls, 2000 tons; time required to take off old rolls and to put in new pair, 10 hours; number of hands required at the crusher, 3; cost of rolls, 18*l.* 3s.; labour changing rolls, including cost of iron wedges, &c., 27s. 6d.: together, 19*l.* 10s. 6d.

Redemption of rolls, less allowance for old rolls	£0	0	1¼
Labour cost	0	0	2¼
Steam power (five horses)	0	0	5
Wear and tear of machinery, oil, &c.	0	0	1
Cost of crushing per ton of stuff	£0	0	9½

The following table affords particulars connected with the dimension and speed of German mills, results obtainable, and horse-power required:—

	Diameter of rolls in inches.	Length of rolls in inches.	No. of revolutions of rolls p. min.	Speed on face of rolls per minute in ft.	Quantity of mineral reduced p. hr.	Horse-power required.
Metalliferous ores and mineral.	36	10	10–20	90–180	5 tons	5 –8
	27	10	12–20	80–140	4	4 –5
	21	10	15–20	80–110	3	3 –4
	15	10	25–30	80–110	2	2½–3½
	12	10	30	90	1½	2 –3
	10	10	40	100	1	1 –2½
			(Hand crushers.)			
	10	10	6– 9	15– 20	½	3 to 4 men.
	6	10	50		¼	2 to 3 ,,
Coal.	36	30	20–30	180–270	25	4 –6
	36	20	20–30	180–270	15	3½–5
	27	30	25–35	170–240	25	4 –6
	27	20	25–35	170–240	15	3 –4
	21	30	30–40	160–270	20	3 –4
	21	20	30–40	100–210	10	2 –3

When disseminated minerals are to be reduced to an impalpable condition they are frequently subjected to a frictional and compressive influence. For this purpose three different machines—the edge, horizontal mill, and arrastre—are employed. The former may be described as consisting of an arrangement in which circular discs of iron or stone are made to traverse the outer circumference of a flat or slightly conical basin. The ores are thrown into this basin, and kept under the runners by means of an iron scraper.

After being subject to this action for a sufficient length of time they are removed, and a fresh charge is introduced. The horizontal mill is similar in its construction to a flour mill. The ore is first reduced to a small size, and subsequently introduced between stones. A more primitive type of mill is known as the arrastre, which consists of a circular bed of basaltic or other suitable rock, a vertical spindle of wood, one or more arms, to which are attached grinding stones, frequently set in motion by mules or horses.

Edge mills, when in perfect condition, will give good results. A cast-iron trough, 7 ft. in diameter, with two runners, 6 ft. diameter and 12 in. wide, will grind 2½ tons per week; but as soon as the axles, wrought-iron rings, and cast-iron bottoms begin to wear hollow, and to lose their even surface, the grinding is rapidly diminished, and the cost is proportionately increased. On a large scale this apparatus, for fine grinding, has usually been advantageously superseded by the ordinary stamping mills. In fact, experience has shown that for comminuting large quantities of hard rock the simpler the machinery employed the better, and that nothing will probably equal the stamping mill, both as to facility of repairs and duty performed for the motive power employed.

The arrastre performs a bad percentage of duty for the unit of power required; still, when basaltic rock is obtainable for grinding stones, and an abundance of water-power exists, this method of grinding may in some places be found economical. The augmentation of bulk by the wearing of the stones is a feature which may demand consideration when cost has to be distributed over roasting and other processes.

JOHN DARLINGTON.

NOVA SCOTIA GOLD FIELDS.

SIR,—From reliable correspondence I submit the following details:

WAVERLEY.—The De Wolfe Mine made a good profit in February, and its owners look for even better returns next month. Mr. B. C. Wilson has for some weeks been working the Bürkner Mine on tribute, and is making satisfactory progress. Mr. Clarke still runs the American property. What is wanted to make this district resume its old prestige is the consolidation of existing interests, and adequate capital for extensive development. The above properties combined under one management, and supplied with the needful hoisting and pumping machinery, could easily be made to yield 2500 tons a month, which even at the rate of 10 dwts., an exceedingly low but paying average, would give 15,000 ozs. for the year's product.

OLDHAM.—The Sterling Mine is at a standstill. The St. Andrew's continues to yield well.

MONTAGUE.—The reports are still good, but no details given.

CARIBOU.—Messrs. Touquoy and Jennings are the only parties working. The former intends to have a crushing in April. Both are taking out rich quarts.

UNIACKE.—Operations are limited, but there is a talk of some revival in the spring.

ISAAC'S HARBOR.—Mining at a stand. Part of the Gisborne caved in last November, and new shafts have to be sunk before any output of quartz, sufficient to keep the mill going, can be looked for.

WINE HARBOR.—Mining has improved here. The Eldorado is stated to have given $2000 profit in February.

TANGIER.—The Strawberry Hill remains productive. No reports from the Humber and other claims.

SHERBROOKE.—The several mines look well, and seem likely to yield as much as was raised in February. The Wellington Mine has not looked better the last three years than at present; it yielded 167 ozs. last month. The New York and Sherbrooke gave 144 ozs. of gold. The Dominion yielded 108 ozs.; it is a good mine, but wants to be worked properly to show to advantage. The Palmerston gave 76 ozs.; the returns of this mine will be much increased shortly, as they have cut the Stryker lode in the east part of their claim. This lode is 6 in. wide, and shows gold well, and is good for 3 ozs. per ton; some say 6 ozs., but 3 ozs. is nearer the mark. Cleverdon and Co.'s claim gave 56 ozs., and never looked better than at present. The Excelsior Mine has the Cleverdon run of gold dipping into it, and every month will increase its length. One new shaft is 35 ft. from surface, and there will be a trial crushing to report by next mail—that is, if the water does not increase and stop the work. On the whole, the weather has been wet, and very much against the tributers. ACADIENSIS.

London, March 29.

FOREIGN MINING COMPANIES.

SIR,—It is high time that shareholders bestirred themselve to check the monstrous expenses uselessly incurred about their London offices. There have been mining companies meeting within the last ten days spending their 120*l.* or 200*l.* a year upon their office whilst making no returns to the shareholders. What is the use of seven or eight directors, besides a professional manager and secretary, merely to open the monthly despatches, and give directions about finance? No company should spend more than (say) 500*l.* per annum upon its London management, unless its transactions are exceptionally large. Under the present system the mine must be a great success (and we know how rarely this is the case) to give any satisfactory return to the shareholders, whilst those concerned in the management (many of whom are utterly ignorant of mining or even ordinary business) receive a handsome income. Again, in many companies (though there are handsome exceptions) where the directors have spent all the capital, they still cling to their fees, till the shareholders rise in anger and protest. The sooner shareholders show they are not merely sheep to be shorn the better. A SUBSCRIBER.

CLARA CONSOLS SILVER-LEAD MINING COMPANY.

SIR,—In consequence of the many enquiries as to the operations of the Clara Consols Company, and also in consequence of the shares not having been brought upon the Mining Market, it is considered advisable to state publicly that the Clara Mine is as *bona fide* progressive an adventure as any in which mining investors and speculators could be interested, or that should concern the Mining Market, and it might not be considered mistimed, as this undertaking has not been kept before the public, to state that the company was formed nearly 12 months ago for working the sett on an extended scale, or rather two setts—Old Clara and adjoining ground, situated near Ponterwyd, and 11 miles from Aberyswith, Cardiganshire; the additional or adjoining ground south of the Old Clara sett being estimated as of great value, inasmuch as a vein of lead ore of more than ordinary promise has been discovered. And it might be as well to add that the Clara mining property was capitalised into 5000 shares of 5*l.* each=25,000*l.*

Doubtlessly four lodes traverse the whole ground, embedded in the well-known mineral-bearing light-blue clay-slate formation of the district, and being identical with the geological features of the adjoining mines, and also in parallel group with greatly productive mines lying north, south, and west. Those mines lying in proximity being well established on account of the large amount of profit derived, compared with the outlay, and being considered equal for permanent profit to any in the United Kingdom. Briefly, then, Clara Consols Mine is situated immediately north of and adjoins the rich Powell United and Llywernog Mines, west of the Bog and Ponterwyd, Cefn Brwyno, Goginan, Bwlch Consols, Cwm Erfin, South Darren, East Darren, and other prolific mines adjoining to the north and west; and on the south by the Ystumtean, Frongoch, and Lisburne Mines. In fact, Clara Mine is surrounded by the best lead-producing mines in the county of Cardigan.

At the time of the formation of the company one of the Clara lodes had been worked at a depth of 32 fathoms, the deepest level from which ore was raised, upon tribute at from 7*l.* to 8*l.* per ton, the tributers having at their own expense to draw and dress the ore ready for market, earning good wages, and leaving a good margin of profit for the adventurers, even on their limited scale of working, and notwithstanding the difficulties under which the mine was at that time worked. But, notwithstanding the former limited scale of working, it has been found that the former adventurers effected a considerable saving in time and outlay towards enabling the Clara Consols Company speedily bringing the property to a profitable state of working.

It was stated that in the Clara Consols prospectus that there was every facility for carrying on the underground and surface workings with economy, there being adequate water-power for pumping, drawing, and crushing at all times, consequently rendering steam-power unnecessary, and that as the turnpike-road from Llanidloes to Aberystwith was within 100 yards of the dressing-floors the ore would be carried at a cheap rate to the Aberystwith shipping port. At the time the company purchased the property the lode in the engine-shaft, which had been sunk 32 fathoms from the surface, had been intersected by cross-cuts, extending for several fathoms, and the lode in this bottom level was throughout about 4 ft. wide, and was worked upon tribute, as before stated.

Since the formation of the company two powerful water-wheels have been erected, an engine-shaft drained, repaired, and secured to the 32, sinking below being rapidly carried on, levels are being driven at the 22 and 32, and excellent lead ore is raised therefrom. A shaft has also been sunk on a south lode down to 11 fathoms, now in good ore ground; the back of this lode has been proved for over half a mile, and in several places lead and blende are cropping out at surface. A large extent of ore ground has been laid open, stoping is actively carried on, and at the present time a large quantity of ore is on the surface ready for crushing, which will commence in about a month.—*Great Winchester-street, E.C., March* 30. W. BATTYE.

[For remainder of Original Correspondence see to-day's Journal.]

ECONOMISING FUEL, AND PREVENTING SMOKE.

An improved economiser, the essential feature of which is the application of a forced blast through the mass of fuel in a fire-place having no fire-bars, has been patented by Mr. J. M. STANLEY, of Elwy Hall, Rhyl. The inventor states that he does not confine himself to any particular kind of blast. Any of the known methods of obtaining one may be employed; but, for the sake of convenience, he generally uses a jet of steam (by preference superheated), which is injected through the nozzle of a steam-pipe, having about a 3-16th aperture, into the mouth of a blast-pipe, leading to a perforated cast-iron tube, placed in the body of a fire-place, under or in front of the boiler. Thus a powerful blast is induced, and impelled through the perforated tube into the fire. The necessary oxygen for combustion being supplied by mechanical pressure, a chimney draught is not necessary. By contracting the outlet for the waste gases, a pressure of heat and flame is made to impinge upon all the heating surfaces of the boiler, without interfering with the progress of combustion. In ordinary open fire-places, with long chimney-stacks, the greater the draught the less is the pressure of heat upon the surfaces of the boiler, and the quicker it passes into the chimney the greater is the waste of fuel. Several other advantages are also claimed for the economiser, among which we may name one of no small importance—that fuel of an inferior kind, and, of course, consequently low price, can be substituted for that of more costly description, and be made to do the necessary work in a highly satisfactory manner. Indeed, those who have tried the experiment assure us that the most inferior fuel will, with this apparatus, generate as much steam as superior coal in common fire-places; and, in many cases, the small slack, such as is thrown on the waste hill at the pit, has been used with great advantage. From what we have already said, it will be seen that the invention, when applied, has a twofold effect. In the first place, it economises the consumption of fuel, by rendering the combustion of the gaseous products of the fuel more perfect, and it thereby also prevents the emission of black or opaque smoke from the chimney; and, secondly, it causes the heat evolved by combustion to impinge more effectively or powerfully upon or against boiler or other heating surfaces or flues before passing into the chimney. In the case of Cornish and other similar tubular boilers, the front part of the boiler tube or tubes is used for the fire-place, but in lieu of the ordinary fire-bars there are introduced along the bottom of this portion of the boiler flue or flues a metal tube or tubes, perforated at the top and sides, as may be required; this tube may be either of a circular, elliptical, or any other suitable shape, in section according to the size or form of fire-place, and may be either in one or more pieces. For ordinary tubular boilers the inventor prefers to have the upper part of the metal tube, which is perforated, in loose parts, for the convenience of replacing them when worn out. This tube extends from the front part of the boiler to the bridge air chamber, and is provided with a throttle valve at the inner end, which is worked by means of a connecting-rod at the front of the boiler. The bridge air chamber is formed by two parallel partitions across the flue of the boiler at the end of the fire-place; the space betwixt the two partitions forms the said air chamber, and is covered with perforated metal or brickwork. In some cases the front part of the perforated tube is left open to the external air, and by means of a suitable pipe or pipes a jet or jets of steam are injected into the tube for the purpose of inducing or propelling a blast, which is forced through the perforations in the said tube into the fire.

After coaling the fire, and when a partial combustion is going on in the fire-place, or black or opaque smoke is being emitted, the valve before mentioned is opened, and allows part of the air to pass directly through the tube into the bridge air chamber, and thence through the perforations at the top of the bridge. This air in passing through the hot tube and air chamber becomes heated sufficiently to effect the combustion of the smoke and the gaseous products of the burning fuel as they pass over the bridge. In other cases, the front part of the perforated tube is closed by means of a cast-iron box, fitted with a blast pipe at the side, and an air-tight door in the front, through which the ashes and refuse products of combustion may be removed; the blast may be either driven through the pipe at the side of the box by means of a fan or blowing-engine, or be induced or propelled by a jet or jets of steam, as before described. By these means of supplying fire-places or furnaces with the air necessary for the combustion of the fuel a high chimney stack for inducing a draught is, as we have before stated, rendered unnecessary, and by contracting the outlet for the products of combustion by means of a damper or valve the heat is caused to impinge more effectively and for a longer period against or upon the heating surface, and thus operate more powerfully than when passing over such surface in the usual way. For egg-shaped and similar boilers, a cast-iron fire-box is used. It may be ogee, semicircular, or elliptical in section, as the case may require. This fire-box is fixed in a chamber of similar shape; its sides are perforated with holes inclined downwards to prevent the small fuel or ashes from falling into the chamber. A blast of air and steam is forced under the fire-box and through the holes into the fire and into an air chamber formed at the end of the fire-place, as before described. A pipe, in which a throttle valve is fitted, connects the two chambers; in this case, the jet of steam is injected into a pipe or pipes placed at the end of the boiler, and leading into the chamber under the fire-box. The fuel is supplied through doors as in common boilers. For marine or locomotive boilers, a fire-box is used having several perforated tubes, semicircular or quarter-circular in shape, and through these the blast is forced by steam jets, as before stated. Arrangements for regulating the blast and for forming an air chamber, and also for consuming the smoke, being provided, as before described.

The whole of these arrangements are illustrated by the engravings.

FIG. 1.

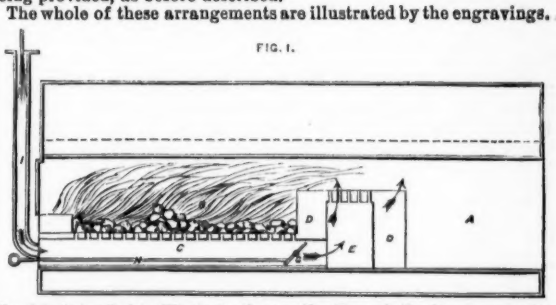


Fig. 1 is intended to illustrate the application of the improvements herein described to a single-tube Cornish boiler: *a* is the tube; *b*, the space usually occupied by the fire-bars; *c*, the perforated tube substituted therefor; *d*, *d*, a double bridge; *e*, an air chamber; *f*, a perforated plate covering the same; *g*, a valve fitted at the end of the perforated tube *c*; *h*, a rod for opening and closing the same when required; *i*, a blast pipe; *k*, a steam pipe, through which jets

FIG. 2.

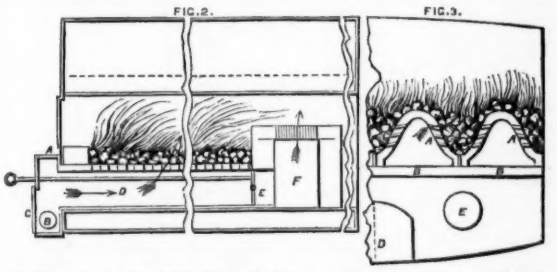


FIG. 3.

of steam are driven into the blast pipe *i*. Fig. 2 shows a modification of the improvements, in which a close box, *a*, is fitted to the outer end of the perforated tube, closing the same air-tight; this box is provided with a blast pipe *b*, which enters it at the side; *c* is the air-tight door through which the ashes are removed when open; *d* is the perforated tube; *e* is the valve opening and closing the inner end of the tube; *f*, the air chamber. Fig. 3 is intended to illustrate the mode of applying the improvements herein described in cases where the fire-places or furnaces are of increased width and length, and in which case, instead of using the perforated tube, a number of perforated plates, formed as shown at *a*, *a*, *a*, are introduced; these plates are supported upon the cross bars or bearers, *b*, placed from 2 to 3 ft. apart (more or less). These plates are made of sufficient length to extend from bearer to bearer. The perforations *c*, *c*, through which the air to the fuel is drawn or driven are inclined, as here shown, to prevent the fire from falling through. The outer end of the fire-place is closed air-tight, and the blast driven in through the blast pipes *e*, *e*, of which the number may be regulated as required; *d* is a door, which closes air-tight, and is provided for removing the ashes when necessary. At the inner end of the fire-place an air chamber is formed, and fitted with one or more valves, as before described. Having ourselves seen the apparatus in full operation, we can bear testimony to the efficiency with which it works, and the excellence of the results which it produces. The consumption of smoke is secured in a highly satisfactory manner, and for the economy which is secured we have favourable testimony, based upon experienced.

SEPARATING AND CLEANING COAL, ORE, &c.—The invention of Mr. G. W. HICK, Leeds, consists of one or more sets of bars or rollers mounted in a frame, and capable of rolling or performing an entire or partial revolution on or about their own axes. Spaces or intervals are left between the bars or rollers to afford passage to such materials as are intended to pass between them. These spaces may be contrived, regulated, or adjusted to accommodate the apparatus to various gauges or sizes of substances. The bars or rollers are so actuated that all those composing one set shall turn or roll in the same direction. The sets may be placed besides each other or otherwise. The breadth of space or interval between the rollers of one set may differ from that between the rollers of another set. One set may turn in one direction and a parallel set in another direction, the rollers composing each set, however, turning respectively in the same direction. The substances to be treated are fed to or on the bars or rollers, to which rotary or rolling motion is communicated, and the smaller particles pass between the bars or rollers, while the larger particles do not.

IRON AND STEEL INSTITUTE.

A second annual general meeting of members was held at Willis's Rooms, St. James's, on Tuesday,

His Grace the Duke of Devonshire, K.G., in the chair.

The Noble President said the first business of the meeting was to appoint two gentlemen to act as scrutineers in order to determine the result of the ballot for new members.

Messrs. Thomas Bell and Joseph Whitwell were appointed to make the scrutiny.

Mr. J. Jones (the secretary) then read the report of the council, in which it was stated that there were at present 347 members on the books of the Institute, which was exclusive of the 37 names ballotted for at the present meeting. The titles of the several papers read before the Institute during the year were stated, and are already familiar, as well as the contents of them, to the readers of the *Mining Journal*. Referring to the labours of the committee appointed to enquire into the distribution of the iron ores of Great Britain, it was mentioned that the officers of the Geological Survey had been communicated with, but it was ascertained that there were no funds at the disposal of the Survey applicable to the analysis of iron ores. It was deemed undesirable that the Institute should pay the Survey officers for services; the council, therefore, thought it best for the Institute to take up the matter independently. Mr. Brogden had reported favourably upon the proposition to co-operate with the Scientific Societies' House Accommodation Committee, and it was mentioned that it had been resolved to proceed with the proposition to build at a cost of from 35,000*l.* to 40,000*l.* With regard to the next meeting, it was stated that the council had received an invitation to hold their summer meeting in the Midland counties.

The financial position of the Institute is highly satisfactory, the accounts showing a surplus of revenue over expenditure for the year of 93*l.* 8d., which left a net available balance of 42*l.* 5d., after clearing of the previous year's deficiency.

The President thought they must all feel that the report was of a very satisfactory character, and congratulated them upon the prosperous position of the Institute.

Lord Frederick Cavendish moved that the committee to enquire into the distribution of iron ores in the United Kingdom be requested to continue its labours. He might congratulate the members that they had an Institute which would undertake such work when a public department refused to do it.

Mr. J. B. Pease seconded the resolution, which was put to the meeting, and carried unanimously.

Mr. Barker said that he had been deputed to invite the members of the Iron and Steel Institute to visit the trade of South Staffordshire. He could not promise to show them as much as they could see in the North of England, but they would have the opportunity of examining iron working as it had been successfully carried on of old, and the conversion of the metal into the forms most useful for the purposes of every-day life, and he could promise them that they would receive a very hearty welcome. He then formally proposed that the next general meeting of the Iron and Steel Institute be held in South Staffordshire.

Mr. Bennett seconded the resolution, which was put, and carried unanimously.

Mr. I. L. Bell desired, before his Grace left the chair, to offer a few observation upon the admirable manner in which he had fulfilled the office of President, remarking that much of the success of the Institute was due to the manner in which his Grace had introduced it to the public. He concluded by proposing a cordial vote of thanks to his Grace the Duke of Devonshire for his valuable services as President of the Institute during the past two years.

Mr. J. Brogden, M.P., seconded the resolution, which was carried with acclamation.

The President said he had to thank his friends, Mr. Bell and Mr. Brogden, for the very kind way in which they had proposed the vote of thanks to him, and his friends around for the very handsome way they had responded. He was glad to think that he took leave of his official position in the Institute when it was in such a prosperous condition. He believed it was well on its legs, and hoped it would continue to progress as it had done.

Sir Joseph Whitworth proposed, Mr. J. Ramsden seconded, and it was unanimously resolved, that the best thanks of the meeting be given to the council and officers of the institute.

His Grace then called upon Mr. Bessemer to assume the office of President, and requested him to deliver his address.

Mr. Henry Bessemer then took the chair, and read his address:

Among the many important problems still waiting for solution in the malleable iron manufacture is the process of mechanical puddling, a process which presents so many practical difficulties to its successful accomplishment as to have hitherto heavily taxed the inventive talent and perseverance of many able men, who, though baffled for the time, have returned again to the charge, full of energy and determination. Most of the members of the Institute had an opportunity, during their visit to Wales last summer, of seeing the highly ingenious apparatus designed by Mr. Menelaus, of Dowlais, for this purpose. That such appliances should not have accomplished all that was desired of them is, in itself, a standing proof of the difficult nature of the task he had taken in hand. The want of success that has hitherto awaited these efforts is the more to be regretted because the work of the puddler is one so laborious, and so exhausting to his physical and vital powers, as to render it desirable for every reason of humanity that hand puddling should be superseded by mechanical force. The advances made in this direction at the works of M. de Wendell, and at other works in France, are most interesting. Through the kindness of Mr. Menelaus, the committee formed to report on this process will have an opportunity of witnessing it in operation at the Dowlais Works as soon as the apparatus can be got into working order. While these laudable efforts are still progressing in the mechanical department of the iron manufacture, the chemical side of the question has not been lost sight of. It will be remembered by many present that in the early part of this century the various qualities of the iron of different districts were considered as the simple and inevitable result of some radical difference in the iron itself, such as we meet with in different kinds of wood, and in other organic substances. The science of chemistry has, however, long dispelled these erroneous notions, and shown that the simple elementary substance, iron is precisely the same all over the world, and that the great variety in the quality and properties of this metal, as found in commerce, depended entirely on the quantity and number of other substances retained in combination with it, and hence that it might be possible to produce from every kind of iron ore a pure and perfect metal. The great encouragement which the enunciation of these facts at once gave to the manufacturer led him to study the best means of purifying and separating from iron the deleterious matters found in combination with it. These efforts have had the happiest results, although we are still very far from the ideal standard of perfection which contemplates the production of an equally pure iron from all the known ores of that metal. This much, however, has been accomplished; the rule of thumb has given way before the proofs of chemistry, and the iron manufacturer of to-day no longer believes in some occult difference in the nature of the iron he treats, but his well-ordered laboratory furnishes him daily with the quantity and quality of the deleterious matters which his raw material contains. * * * *

Among the workers in this direction is Mr. Henderson, of the United States, who proposes to remove these deleterious substances by the employment of fluoric acid, in combination with oxygen; I have, however, not yet received any information as to the results obtained by the means proposed. A second competitor in this interesting field of research is Mr. Sherman, also an American gentleman, who has been carrying on a number of experiments at the works of Sir John Brown, at Sheffield, and at other places. The invention, as I understand it, consists in the use of iodine, or its compounds, brought into contact with the metal in the puddling furnace, or in the Bessemer converter. * * * * Without having at all studied the question, it would at first sight appear that, instead of employing so expensive a substance as iodine in its manufactured state, the half vitrified ashes of seaweed, which are rich in iodine, might be applied direct to the iron in its first process of manufacture in the blast-furnace—or by simply charging on with the rest of the material the requisite quantity of seaweed in its raw state, or only previously dried. The carbonate of soda, chloride of potassium, and other salts, derivable from the seaweed, would in any case form an excellent flux, and lessen the quantity of lime required to produce a liquid cinder. It would also appear that the ashes of seaweed, in the form of powder, could most readily be carried by the blast through the tuyeres into the Bessemer converter at any stage of the converting process. I have found, in my early experiments, that blowing crude American pot ashes into the metal produces a very liquid cinder, but the tuyeres are more rapidly worn than when air alone is used. Among the most important improvements lately effected in the manufacture of steel is the development, by Sir Joseph Whitworth, of the system of casting under hydraulic pressure. The casting of large masses of steel free from air bubbles has long been a source of difficulty, owing chiefly to the fact that at the extremely high temperature of molten steel a certain quantity of oxygen is absorbed and retained by the metal so long as this high temperature is kept up, but which it cannot keep in combination when the metal is cooled down to the point at which it commences to solidify; hence, when the fluid metal is received in a cold mould large volumes of gas are given off, some of which becomes entangled in the solidifying mass, and is there retained, forming numerous cells or honeycombs. A similar result is met with in finery iron, when it is "overblown;" carbonic oxide gas is liberated in abundance during the solidification of the plate metal, and gives rise to the peculiar cellular structure, so well known. Another defect, inherent in steel castings, owes its origin to the crystalline structure assumed by the metal in the act of solidification. So long as the metal retains undisturbed the original crystals formed by casting the mass is only feebly coherent—its tensile strength is less than half to which it rises when hammered or rolled. It will bend only a few degrees from the straight line without fracture, while its power of elongation is also extremely limited; but if considerable pressure be applied while the steel is passing from the fluid to the solid state the crystals, which would otherwise become almost independent structures, are united or welded together so perfectly at this high temperature, and in their almost plastic state, as to develope the most perfect cohesion of all parts of the mass, probably more perfect than any subsequent operation of hammering could effect. * * * * *

In justice to Sir Joseph Whitworth, I feel bound to say that I have no doubt whatever but that he was wholly unaware of the existence of my previous invention at the time he brought forward his system of casting under hydraulic pressure, by which the material now known as "Whitworth metal" is produced. Certain it is that we owe to him the development and first practical application of this system of casting steel under a pressure transmitted direct to the fluid, or semi-fluid metal, by a plunger actuated by hydraulic force. It is difficult to estimate the importance of any process by which a malleable metal, stronger than forged iron, might be readily cast at once into the desired form; but it is just this question of form which still presents the difficulty. It will be readily understood that any plain parallel figure, like an elongated shot, or a solid cylinder or ingot, may be compressed by a plunger at one end, and a tolerably uniform effect be produced throughout the mass of metal; but it is far different with more complex forms. * * * * * * *

Among the various improvements that have within the last few years been introduced in the manufacture of iron few are of such magnitude and importance as the production of armour-plates, a manufacture called into existence by the advances made in modern artillery. The rapidity with which manufacturers have responded to the call thus made on their skill and enterprise affords an excellent example illustrative of the way in which the engineering talent of this country seem capable of keeping pace with the ever-increasing wants both of the arts of peace and of war. The production of malleable iron, of the excellent quality with which these plates are made, also affords another proof of the rapid progress made in this department of our great staple manufacture. In the early part of these remarks I proposed, with your permission, to touch on one or two subjects, which it appears to me are matters of great importance, not only to the members of the Iron and Steel Institute, but to the whole engineering profession, as well as to the public in general; and when I reflect on the thoroughly practical character of the many eminent manufacturers and engineers whom I have now the honour to address, the conviction forces itself upon me most strongly that such an organisation as ours is one eminently calculated to solve many of the important practical questions, both in connection with the manufacture of iron and steel and their employment for constructive purposes, which individuals, unaided and alone, might well shrink from grappling with. It is from the members of the Iron and Steel Institute that the world looks for a practical definition of the terms iron and steel. It is true that, from a chemical point of view, the line of demarcation which separates these substances is as little marked as the rainbow's hues, which melt imperceptibly into each other, leaving no part at which it may be said here one ceases, and there the other begins. Thus it is with iron and steel, which passes by almost imperceptible gradations from grey iron through every stage of mottled and white to hard steel, and from it to steel in its mildest form, which passes into malleable iron almost unmarked. Although admitting the truth of this view of the subject, when considered chemically, the practical man recognises in the metal iron a substance which, in its more or less pure or alloyed state, and under its physical condition of cast or wrought-iron, possesses properties so different and so anomalous that its classification becomes both easy and natural, hence three primary divisions have everywhere been recognised—cast-iron, wrought-iron, and steel; and allowing a certain latitude in each class, there seems no reason to dispute the propriety of such a definition. With regard to the two former—cast-iron and wrought-iron—their manufacture has been pursued so long in every civilised country that their nature and physical characters are well known and universally recognised; but, with reference to steel, this can scarcely be said. In the latter part of the last century the ingenious clock-maker, Huntsman, found that steel made by the cementation of iron bars was rarely perfect enough in its structure to yield a clock-spring of equal strength throughout. Unable to obtain a sufficiently reliable material, he hit upon the happy idea that the fusion of the bar steel, if practicable, would furnish a far more reliable material, perfectly homogenous in structure, and free from the numerous flaws which the accidental envelopment of wood ashes on the Swedish bar so frequently caused. Fortunately for mankind, this bright idea was brought to the test of practical experiment; and, after numerous failures of every kind, Huntsman was at last enabled to construct furnaces that would furnish the necessary high temperature, and crucibles that were not destroyed at a single heat; he thus at last succeeded by laborious efforts in producing cast-steel—the most valuable and perfect condition in which the metal iron is known. * * * * * * * * * *

The great extension of the cast-steel manufacture within the last few years its reduced cost of production, together with the facility now possessed of making it of a mild or tough quality, has brought it into competition with wrought-iron for several most important uses in the arts. It is this fact which opens up the important field of enquiry to which I desire especially to direct your attention. So recent has been the application of mild cast-steel to engineering structures, that the civil engineer finds himself at a loss to estimate its value as a constructive material, and its applicability to the work he may have in hand. If he desires to use wrought-iron, he has a thousand examples before him. He has printed tables and formulæ almost in every book he turns over; and in all this he is confirmed by numerous examples, and by his own practice and observation; but if he desires to employ steel for any new structure, be it the roof of some large building, a span of unusual length across a river, where intermediate piers are almost impracticable, or in any other case, in which he hopes by economy of weight he may obtain that in steel which he cannot hope to accomplish with a weaker material, where, under such circumstances, is he to look for the desired information? Where are the numerous tables he is wont to employ? Where the formulæ deduced from practice to aid his calculation? Where the example from which he can draw his own conclusions? It is to fill up this void, and to supply such information, on the authority of the first practical men in this country, that I propose to establish proofs so well authenticated and are irrefragable, as to form a sure basis for after calculation, and afford means of estimating the strength of structures, and to supply tables on which implicit reliance can be placed. The great point, I take it, will be to make such tests comparative with iron in all cases, and under circumstances equally well adapted to show the comparative value of each material for structural purposes. This is the more necessary, because I believe that many of the tables and formulæ at present in use were made at a time when wrought-iron had not arrived at so perfect a state of manufacture as that to which it has now attained. It would be, therefore, necessary to repeat every test in the wrought-iron and steel of the present period, in order to ascertain with precision their relative power of resistance, under identical conditions, or under such special conditions as may be more favourable to either material. Should it be thought desirable that the Iron and Steel Institute should investigate this subject, I would propose that a series of preliminary experiments should be made, showing the resistance of the different materials, both to tensile and compressive force, as well as to violent concussions and long continuous strains. * * * I speak of these as preliminary tests only, because I think the members of this Institute will agree with me that it is not the simple breaking or twisting of a single bar, free at all parts except in one particular direction, that is wanted; but it is the more complex strains that we have to encounter in practice that it is desirable to ascertain and to record. Thus it would be necessary to make several beams and girders of such form and construction as will fairly represent the uses to which iron and steel are applied in practice. It is in order to construct these test girders of proper proportions that I propose to make the first or preliminary experiments on the materials of which they are constructed, and I would further propose, that any errors arising from the imperfect apportioning of strength in the different parts of these girders should be corrected by re-constructing them after their weak places have been shown by a first trial, and thus arrive at a structure, as near as may be, equally strong at all points, and showing the exact amount of material necessary to withstand the tension and compression of the several parts of the structure. * * * * * * * * * *

It will at once be obvious that in the manufacture of cast-steel great facility is afforded in making large masses as compared with the production of such masses of wrought-iron; thus, where steel is employed for the top or bottom web of a large girder, it is evident that the simplest way would be to roll a single slab of the desired dimensions, thus avoiding the labour of cutting plates to size and punching and rivetting them, and thus also avoiding the great loss of strength consequent on the loss of section at the rivet holes. It would, therefore, appear that on any comparison of the two materials for a given structure the facility which steel affords of supplying large masses must be taken into account. Nor is this all, for steel may be made with equal facility, either hard or soft, and in the upper web of a girder steel specially adapted to bear a high compressive strain may be most advantageously used. A single glance at Hodgkinson's cast-iron girder shows at once how small a top web is necessary in a material so difficult of compression as cast-iron, while its weakness under a tensile strain is in like manner exhibited by the massive proportions of the lower web. Although the difference in the two qualities of steel will not allow so great a difference in the proportions of a steel girder as we see in the cast-iron one, it would, I believe, be of sufficient magnitude to considerably alter both the weight and cost of the structure. This harder material might be used in all cases where compressive strain alone was used, and in order not to complicate the manufacture by numerous qualities of steel one special quality might be fixed on for this purpose, and be distinguished from the usual make, as steel for compression.

It would be no less interesting to ascertain how far the properties of wrought-iron and steel combined in one structure could be advantageously employed with the view of affording, with a given weight, or at a given cost, the greatest amount of stability in structures of this kind. I have hitherto spoken only of beams or girders as affording examples of the nature of the tests which I deem desirable; but it will be obvious that these researches should be so modified and conducted as to afford correct data to the shipbuilder as well to the engineer. Indeed, I believe that steel has already been somewhat largely employed, in combination with iron, for shipbuilding by the late chief constructor of the navy, with the intention of developing a greater amount of strength with a given weight of materials. I believe it will be found that the rate of expansion of iron and steel within the limits of atmospheric temperatures will oppose no practical obstacle to their combined use. * * * * *

The great development of the mechanical arts within the last century has rendered it extremely desirable that certain uniform standards of size or measure should be set up, by which a uniformity of practice has, in many cases, resulted. Thus, we owe to Sir Joseph Whitworth a series of standard gauges, which have been universally adopted in engineering establishments, to the great advantage of the manufacturer and the user of the machinery in which these accurate and definite sizes of parts have been introduced. The same may be said of the Whitworth screw-threads, so generally employed in our mechanical workshops. But, perhaps, the most marked application of the employment of standard screw-threads is found in the manufacture of welded iron gas-pipes, from which we derive an amount of advantage which, owing to our familiarity with it, is rarely appreciated to its full extent. So obviously advantageous is this system that we happily see its principle extending from day to day, even to an entire mechanical structure, as in gun-making, where every part is made to a standard pattern, so that the possession of a few duplicate parts will enable a broken or otherwise useless rifle to be perfectly restored in a few minutes, at a cost immeasurably below that which would have been required to make as single part to order. And it must be borne in mind that this system of standard sizes not only affords great advantages to the general public, but it lessens the cost of production by admitting the employment of special tools and appliances for the production of these numerous pieces, which could not be employed in the chaotic state reigning in our manufactories before these principles were applied. * * * It is now evident that there is no need in practice for this infinite variety of size and form of rails; we know pretty accurately what is the general average traffic on a line, and the weight of our engines. The work which a rail has to perform is so perfectly simple, and so clearly defined, that there cannot at the present day be any difficulty in establishing a standard rail suitable for all purposes. Thus, suppose we take the double-headed and the Vignoles rail as representing the two classes of rails suitable for longitudinal and cross sleepers, and if we make a heavy, medium, and light one, of each of these types of rail, we should have a choice of six sizes, that would supply all the reasonable demands of our present railway system. Taking these three standard sizes of iron rails, of each class, I would then make three other standards of steel rails, in which the table or wearing surface was identical in each case with the iron standard, but so reduced in weight per yard as to reduce its powers to resist a blow, or to sustain a weight precisely equal to the iron standard, so that in all cases the iron *a b c* rails, and the steel *a b c* should possess the same powers of resistance to a heavy load, or a sudden concussion. We should thus diminish the great apparent difference in price between the iron and steel rail, for it must be remembered that the price per mile, and not the price per ton, is the real test of the cost of rails. The adoption of a standard rail would afford great facilities to the manufacturer by diminishing his stock of rolls, and allowing him to manufacture in slack times, and to supply any sudden demands from stock. It would lessen the cost of production and afford the general advantages to the consumer and producer which have hitherto resulted in all cases from the adoption of universal or standard measures. It is difficult to imagine the state of utter confusion that would have reigned throughout our whole railway system had the gauge differed on every line to the same extent as the rails. The one instance afforded by the broad gauge is sufficient to convince us of the immense disadvantages that would have resulted from such an error, and I doubt not, but should we happily arrive at a universal *a b c* standard for rails, we should in the future look back with dismay on our present chaotic state.

I, therefore, feel a conviction that the time has arrived when a conference with our leading railway engineers would result in the adoption of an iron and steel *a b c* standard for rails, to the great advantage of all concerned. There would of course be no difficulty in supplying, if required, outside sizes at a higher quotation.

The Secretary submitted the report of the scrutineers containing a list of new members elected, and announcing the elections of officers for the ensuing year to be for *Vice-Presidents*—Messrs. W. Menelaus, Robert Heath, and R. Cassels. *Council*—W. T. Crawshay, R. J. Fothergill, M.P.; W. S. Roden, M.P.; Sir J. Whitworth, and Mr. C. W. Siemens.

The Duke of Devonshire had an agreeable duty to perform in asking them to give a vote of thanks to their President. When it was announced at the South Wales meeting that Mr. Bessemer was to be the President, it was felt that it could not be better than to have a man who is identified with one of the most important and successful inventions of the age. His address, which they had just heard, would be found a valuable addition to the store of information at their disposal.

Mr. Whitwell seconded the resolution with much pleasure, remarking that Mr. Bessemer deserved their thanks if it were only for the millenium which he promised them in the way of standard rails. He thought they might well congratulate each other in having found such an excellent successor to his Grace the Duke of Devonshire.

Mr. Bessemer acknowledged the compliment, and the Secretary announced that the proceeding would commence on the following morning for the reading, and discussion of papers.

The proceedings of the second day were commenced by the Secretary reading the preliminary report of the Committee to enquire into the Distribution of Iron Ores in the United Kingdom.

The President congratulated the meeting upon the very interesting nature of the report. It was called a preliminary report, and if they regarded it as a preliminary contribution they might well look forward for much that is useful from the continuance of their labours. And not only was the report itself valuable, but it was especially so as an evidence of the importance which the institute was likely to derive from the appointment of committees of this kind. He regarded the investigation of the iron ores as a stepping-stone to our future success, and considered therefore the committee, whose report they had just received, was entitled to their best thanks, which he had much pleasure in moving.

Mr. Robert Hunt, F.R.S., understood the report to state that in the Statistics given by him for 1869 for Cornwall and Devon, the quantity of iron ores produced in those counties had been understated. In answer to that he might mention that his authority for the Statistics was the returns made to the Stannaries Court. The supposed discrepancy might, perhaps, arise from the fact that in 1869 many mines that were worked before that year laid idle. The hematite deposit was by far the most important, but it should be mentioned that some of that iron was contaminated with copper, which much deteriorated the quality, but some other was contaminated with lead, which was considered to influence the product less prejudicially. There was another point whilst he was standing up which he would like to be permitted to refer to. It was remarked on the previous day that an application had been made to the Geological Survey, and that an unfavourable reply had been received. He wished to take the earliest opportunity of expressing his conviction that there had been some misunderstanding in the matter, or some irregularity in the manner in which the application had been made. He was sure that every member of the Geological Survey was most desirous of assisting to the utmost of their power. Professor Ramsey had told him that as they were approaching the great iron district in the North the officers of the Survey had distinct orders to record facts of special importance to the ironmasters, and he also told him that during the progress of the Survey information had been obtained and published which had led to the opening out of important deposits not previously known.

Mr. Jones was glad to have heard Mr. Hunt's remarks, and in reply to them would state that about a year and a half ago the application referred to in the report was made in the form of a request to Sir Roderick Murchison that the officers of the Survey might be permitted to make a report on the distribution of iron ores generally, and especially on the distribution of the hematite ores. Sir Roderick Murchison replied that at present the request could not be complied with, but that it should have every attention as soon as the Survey was completed. This he regarded as equivalent to a refusal, for if they waited for the completion of the Survey they would probably have to wait until all the hematite ores have been exhausted. He trusted this would be a satisfactory explanation to Mr. Hunt, and that he would believe that the Institute had not made any observation in an unfriendly spirit.

Mr. Hunt only wished to show that as far as the Geological Survey and Mining Record Office could assist the Institute they would be happy to do so.

Mr. Jones then read the report of the committee on Mechanical Puddling.

The President was sure they would appreciate the advantage to be derived from a full investigation of the subject. He regretted that the continental disturbances had prevented the arrival of the machine, as otherwise results would have been obtained in time for the present meeting. With regard to mechanical puddling, however, he was glad to see Mr. Schneider, of Creuzot, present, and had much pleasure in calling upon him for some observations on the subject.

Mr. Schneider had heard his name pronounced, and appreciated the honour of being called upon. He regretted that he could not speak English, but was nevertheless glad to have the opportunity of presenting himself before the Institute. He believed in the process of puddling it was absolutely necessary to have practical knowledge. He had thoroughly studied the process of puddling by mechanical means, and he doubted if the process could be generalised. It could be used to a certain extent, but not, in his opinion, entirely in substitution of manual labour; it was only, indeed, by exception that the mechanical process could be employed; it was very good, but was inadmissible in the majority of cases. The organism of the human body permitted of an amount of elasticity which could not be obtained in a machine. If they could invent something in advance of any contivance they had yet seen the case might be different, but he did not believe that in their present state of knowledge it was possible for them generally to adopt such an invention. It was for this reason only that he had not generally introduced it in his own works at Creusot.

Mr. Bell had last year had the opportunity of examing the apparatus of Mr. Menelaus at Dowlais, and was pleased with the amount of progress he had made. He had heard much of our neighbours being in advance of this country, and had always dissented from that view. He was to a certain extent gratified to hear the remarks that had fallen from Mr. Schneider, as it proved that, at least in the matter of mechanical puddling, the French were not in advance of us. He did, however, hope that something might be done. He would, however, take the opportunity of bidding a welcome to Mr. Schneider, and was sure that every member of the In-

stitute would unite with him in doing so. He had visited Mr. Schneider's works, and had always met with the greatest attention and utmost courtesy.

Mr. SCHNEIDER thanked not only Mr. Bell, but all the English industrials who had most kindly received him. In two visits he had made to this country he had received the most ready assistance. He considered that when one was strong in an industry it was unnecessary to have fear. He at all times willingly received in his works English industrials, feeling satisfied that he could learn as much as he could teach. He had endeavoured to learn the great lesson of modesty, and to understand the leading requirements of industry, hoping for the recovery of his poor country, and with it the revival of its prosperity, and that they might take an example from the great country—England.

Mr. MENELAUS admitted that it was best to get a good strong puddler, willing to put his labour into the work, but he thought they should endeavour to lighten the puddlers' labour. He was hopeful that they would be able to lessen the labour of puddling. They might, at least, do away with part of the labour. He admitted that no one was more ready than Mr. Schneider to introduce improvements, but he hoped to be able to show him that something could be done with mechanical puddling, though he might not succeed in doing away with manual labour altogether, as he thought of doing some time since. He promised the members of the Institute that they should have full details of the results obtained.

Mr. FERDINAND KOHN then stated in a paper "On the Production of Alloys of Iron and Manganese, and on their Application to the Manufacture of Steel," that the properties of alloys of iron and manganese have not as yet been completely investigated, and much difference of opinion exists with regard to the theoretical position of manganese in the process of steel manufacture, though absolute unanimity prevails amongst steel makers as to the practical necessity of employing manganese in the manufacture of cast-steel. Special allusion is made to the well-known spiegeleisen, from the district of Siegen, in Rhenish Prussia, which contains from 7 to 11 per cent. of manganese. A kind of pig-iron is there made from a spathic iron ore, which is a crystallised compound of carbonate of manganese and carbonate of iron. The production of spiegeleisen requires a particular management of the furnace, but with recent improvements the ironmasters of Siegen have learnt to make this substance with hot-blast and coke, utilisation of waste gases, and a high temperature in the zone of fusion. With the best managed blast-furnaces, intended specially for manufacturing spiegeleisen, only from 70 to 80 per cent. of the total annual produce is iron of that class. The quantity of combined carbon in spiegeleisen is about 5 per cent. In adding a dose of spiegel to a charge of decarburised iron it is unavoidable that a proportionate quantity of carbon must be put in for any given amount of manganese which it is desired to introduce into the charge, and this leads to a difficulty in manufacturing very soft kinds of steel, which has always been very seriously felt by all Bessemer steel makers, and which has been overcome only to a certain extent by great experience in the management of the converter. The actual necessity for making very soft steel with Siegen spiegeleisen is to "overblow" the charge to such an extent that there is oxygen enough left in the metal to combine not only with all the manganese and silicon, but also with the greater part of the carbon introduced by the spiegeleisen. This practice has made it possible to apply ordinary spiegel to the manufacture of the softest kind of Bessemer steel; but it is an acknowledged makeshift, and the demand for the richer alloys of iron and manganese has for a long time past been felt by every steel maker in the country. The author particularly described the process for the manufacture of ferro-manganese, that which has been invented and patented by Mr. Henderson, of Glasgow. With proper selection of materials, the average proportion of the alloy obtained by the process is stated to be from 20 per cent. to 30 per cent. of manganese. This can be manufactured at a little more than 7*l.* per ton, exclusive of the royalties. Mr. Kohn considers that the making of these artificial alloys of iron and manganese will be a suitable and remunerative industry, and will form a useful accessary to every Bessemer steel works in the country. The Terre Noire Company use ferro-manganese, with 23 to 25 per cent. of metallic manganese, exclusively used for the manufacture of the softest kind of Bessemer steel, which is required for boiler and ship plates, in the construction of ordnance, and for other similar purposes. The steel of Terre Noire is made from pig-iron, which is run directly from the blast furnace into converters without mixing with other kinds of iron. By the addition of the rich ferro-manganese, instead of the ordinary spiegeleisen, the company have succeeded in manufacturing a special class of steel, which in ductility and capability of elongation is superior to all that is now known in the markets of this country. The company have submitted some examples of their steel plates to Sir William Fairbairn for testing, and the results of his experiments are appended to the paper, together with some remarks with regard to the specimens. Sir William says that the steel submitted for examination consisted of six samples, and taking them altogether they exhibited considerable uniformity and character as regards ductility and strength. The highest as regards tenacity is below the average resistance of steel, but this is largely compensated for by its power of elongation and ductility, and there is nothing comparable to it in any of the various manufactures with which he is acquainted. In its powers of resistance to a tensile strain it stands against the Barrow steel as 27·1 to 32·2, but in ductility it stands in the ratio of ·219 per unit of length to ·092 of the Bessemer steel manufactured at Barrow from the hematite ores. These are important features in the character of this description of manufacture which is admirably calculated for being drawn into the finest kind of wire.

Mr. SNELUS was glad Mr. Kohn had started the analysis of this sample. He thought that every test for tensile strength should be accompanied by analyses. He held that the theory that manganese only served to remove the surplus oxygen and then disappear from metal was not accurate. He had found manganese equal to ·02 per cent. present in moderately hard steel that would not roll, and believed manganese not only removed oxygen, but served to soften the steel, and increase its tensile strength. The manganese in the samples referred to by Mr. Kohn does not account for ductility, unless taken in consideration with percentage of carbon. He had found ·06 per cent. of manganese without much hardening the steel. The Ebbw Vale Company are making good spiegeleisen containing 17 per cent. of manganese. He thought it desirable for the Iron and Steel Institute to know that such a product was manufactured in this country.

Mr. E. WILLIAMS would ask Mr. Kohn how the running iron direct from the blast-furnace into the Bessemer converter was effected? He had found it very difficult, his difficulty being that there always would be some difference in the quality of iron as it run from the blast-furnace. He did not see how the converter could be placed so as the iron could run into it from the blast-furnace. In the large furnaces of the Cleveland district there would be great difficulty in having to tap so frequently.

Mr. BAKER believed that for the production of Bessemer metal manganese was not necessary. He believed that manganese might have an influence in combination with other elements which it did not possess alone.

Mr. BELL remarked that heat played an important part in chemical operations, but by going further you undid what you had been doing. A few years since it was thought water was not separable into its component gases by heat alone, but Mr. Groves showed that by higher heat the oxygen and hydrogen could be separated. It had been mentioned that as silver solidified a large quantity of oxygen was given out, oxygen being dissolved in the silver. Was there, he asked, any analogy between silver and iron? He said not; and when iron began to cool was just when oxygen combined with iron, so that to suppose it was just at that moment that the oxygen was separated from it was a contradiction of terms.

Mr. KOHN said that at Terre Noire the iron was not re-melted. The iron was run into a ladle, and then into the converter. Two furnaces were used, and the ladle was half filled from each. The practical result was that there was no inconvenience felt. At Creusot they had a truck which brought the metal to the converter. When very large blast-furnaces were used for Bessemer steel there would be many converters, so that difficulty would be absent. In reply to Mr. Bell, he would say that he advanced no theory, but merely stated the two opinions entertained.

Mr. SNELUS said that his idea was that the manganese removed the oxygen existing in the iron, and also alloyed with the iron, and thus improved its quality. He believed the gas evolved from the iron in cooling was not oxygen, but carbonic oxide. He alluded to Graham having proved that oxygen was excluded from iron, and mentioned the case of hydrogen and palladium in support of his views.

Mr. BELL considered the position of hydrogen and palladium had no analogy to oxygen and iron—hydrogen and palladium being an undoubted alloy, whilst oxygen and iron was a chemical compound.

The PRESIDENT remarked that if rich alloys of manganese—alloys containing a larger percentage of that metal than spiegeleisen—could be produced in this country, it would be of the greatest importance to steel manufacturers. With regard to the alloy of iron and manganese he might mention he had many years since carefully made an alloy of pure iron and pure manganese, and the result was a material nearly of the nature, as to ductility and other properties, of copper. In the course of the discussion some doubt had been expressed as to the gases liberated in the cooling of iron, and upon this point he could tell them that he had, by permitting iron to cool almost in vacuo, succeeded in collecting those gases, which were submitted to Prof. Henry, and pronounced by him to be carbonic oxide.—Mr. PARRY, of Ebbw Vale, made a few remarks, but they were quite inaudible.

Mr. Walker's paper on "Modern Appliances for Reversing Rolling Mills" was next read, and the author, by means of diagrams, explained several ingenious arrangements, including one for reversing with five wheels, two being in operation on the forward and three on the back motion, and another wherein he got two independent setts of rolls worked with eight wheels, one result mentioned being that he got (usually) a 17-ft. plate, weighing 12 cwts., rolled in 3½ to 4 minutes. There was an ingenious arrangement for instantly releasing, drawing back, and re-running in the plate in case of any hitch occurring after it has entered the rolls, and thus avoiding the spoiling of the plate.

[To be concluded in the Supplement to next week's Journal.]

FOREIGN MINING AND METALLURGY.

Deliveries of Belgian coal by railway have been made rather irregularly, and, as regards Paris, the Northern of France Railway Company has intimated that until further orders it cannot forward any more coal; this state of things is, of course, prejudicial to the revival which had appeared in industry. The question of tariffs continues to excite much attention. Some parties affirm that the French Government proposes to increase tariffs, and to a considerable extent; others contend that coal will not be taxed more than it is at present, as France is in urgent want of coal; and, although the working of the mines of the Nord and the Pas-de-Calais has made progress, they are far from producing all that is required. The exports of Belgian coal into France sensibly exceed, it should be remembered, the whole production of the North of France basin. In the present state of France it is difficult to predict what may take place in this respect; in any case it is the duty of the Belgian Government to take in hand the cause of industrials, and to offer all opposition in its power to all aggravations of charges which at present weigh heavily upon them. The imports of coal into Belgium in December amounted to 22,928 tons, against 19,204 tons in December, 1869. The imports of the whole of 1870 were 223,686 tons, against 214,339 tons in 1869, showing an increase of 9347 tons. The exports of coal from Belgium amounted in December to 134,197 tons, against 388,609 tons in December, 1869. The exports of coal for the whole year were 3,114,851 tons, against 3,581,235 tons in 1869, showing a falling off of 466,384 tons. The exports of Belgian coal increased last year to the Zollverein and the Low Countries, but on the other hand the exports to France presented the very heavy decline of 610,240 tons. The exports of coke from Belgium last year were 594,995 tons, against 687,584 tons in 1869, showing a falling off of 92,589 tons. As regards the value of the coal and coke exported from Belgium last year, it presented a decline as compared with 1869 of 361,309*l.*

At Havre the sale has been noted of 12 tons of copper at 68*l.* per ton, Paris conditions. It must be confessed that the present state of affairs in France is not calculated to secure a revival in business; every description of industrial enterprise has been once more checked among the unfortunate French. At Marseilles, Toka has been quoted at 72*l.*, and refined Chilian and Peruvian has brought a similar price; rolled red copper in sheets has made 84*l.* per ton. At Berlin there has also been more movement; transactions for consumption have been more numerous, and speculation has also somewhat revived. In Holland there has been scarcely any variation in copper. Tin has been held with rather less firmness in Germany, in consequence of the advices received from Holland. At Rotterdam there has been no great amount of business passing in tin. To supply their current wants consumers have been paying 76 fls. for disposable Banca. At Marseilles lead in saumons, first fusion, has made 18*l.* per ton; second fusion ditto, 18*l.* to 20*l.*; lead in shot and rolled and in pipes, 20*l.* 16s. per ton. In Holland lead has experienced no material variation in prices. There is little change to report in zinc quotations.

The advices which have come to hand as to the state of metallurgical affairs in the East, the Centre, the North, and the South of France are not wholly satisfactory. Stocks are considerable, the demand is moderate, and deliveries are not very well sustained, especially in the North and East, where goods traffic has scarcely been resumed in consequence of the Prussian occupation. At Paris the sad disorders which have occurred have paralysed the tendencies to improvement which had appeared in affairs. Before engaging in important transactions commercial men are awaiting the return of peace and order.

The state of the Belgian iron trade is still considered tolerably satisfactory. Orders begin to arrive in rather considerable numbers, and for all descriptions of pig, iron, and plates. Nevertheless, the revival in business will not be complete until a complete pacification is secured in France. Official tables which have just appeared show that the imports of iron minerals into Belgium in December, 1870, were 42,087 tons, against 41,285 tons in December, 1869; for the whole of 1870 the same description of imports amounted to 567,523 tons, against 551,900 tons in 1869, showing an increase last year of more than 15,600 tons. The imports of rough pig and old iron into Belgium in 1870 were 83,799 tons, against 61,599 tons in 1869, showing an increase last year of 22,200 tons. The imports of iron of all kind, minerals excepted, amounted last year to 92,722 tons, against 71,041 tons in 1869, showing an increase last year amounting to 21,681 tons. The exports of minerals from Belgium in 1870 were 178,562 tons, against 164,576 tons in 1869, showing an advance of 14,000 tons. The exports of rough pig and old iron considerably declined last year, when they amounted to 8232 tons, against 14,266 tons in 1869. The exports of wire from Belgium last year remained about stationary, as compared with 1870. On the other hand, the exports of rails presented in December, and for the whole of last year, a sensible diminution; the figures for the whole of 1870 were 122,926 tons, against 136,186 tons in the preceding 12 months. A diminution of about 15,200 tons was remarked last year in the exports of Belgian rails to Russia; the exports to Italy also declined 9000 tons, those to Turkey 12,000 tons, those to England 2000 tons, and those to the Low Countries 800 tons. On the other hand, the exports of Belgian rails to the Zollverein presented last year an increase of nearly 30,000 tons; those to France, an increase of 2400 tons; those to Sweden and Norway, an increase of 1000 tons; those to Spain, an increase of 2700 tons; and those to Egypt, an increase of 1000 tons last year, in round figures. The exports of plates from Belgium last year were 20,705 tons, as compared with 21,058 tons in 1869. Of other descriptions of rolled iron the exports last year were 75,648 tons, against 81,631 tons in 1869; and the whole exports from Belgium of iron of every description, minerals excepted, footed up last year to 249,874 tons, against 273,141 tons in 1869, showing a decline last year of 23,267 tons. These latter totals were made up thus:—

Destination.	1870.		1869.
Russia	62,775 Tons	Tons	73,681
Sweden and Norway	1,889		733
Denmark	317		649
Zollverein	57,994		41,685
Hanse Towns	3,654		4,936
Low Countries	28,902		27,760
England	13,318		11,716
France	30,349		40,094
Spain	3,301		480
Italy	7,723		19,807
Switzerland	2,809		4,109
Austria	1,383		1,391
Roman States	35		28
Turkey	17,810		29,790
Egypt	1,506		1,389
United States	11,924		11,669
Cuba and Porto Rico	2,141		1,101
English possessions	168		56
Brazil	594		659
Rio de la Plata	232		616
Chili and Peru	588		466
Miscellaneous	462		326
Total	249,874		273,141

With reference to the contract for 2000 tons of rails for the Dutch State Railways let recently to MM. de Dorlodot Frères, it should be remarked that the tender of Bolckow, Vaughan, and Co. (Limited) was regarded as conditional—hence it was not accepted.

LONDON GENERAL OMNIBUS COMPANY.—The traffic receipts for the week ending March 26 were 10,215*l.* 13s. 2d.

FOREIGN MINES.

ST. JOHN DEL REY.—Morro Velho, March 2: Produce, second division of February, 11 days, 2403 oltes.; yield, 2·301 oltes. per ton. Sinking in new shafts during February, 28 days—A shaft, 6 fms.; B shaft, 4½ fms.: total, 10½ fathoms.

DON PEDRO.—F. S. Symons, Feb. 27: Produce weighed to date, 4954 oltes.; estimate per month, 6900 oltes.—Mine: Operations are proceeding with regularity; the lode is excavated generally from curve; not of high standard, but a little box work has been taken out to-day, which has not yet been cleaned. Alice's continues to produce fair strake work, but none sufficiently rich for boxes. The quantity of ore supplied from the mine is very large. The cross-cut from Vivian's and middle adit is progressing fairly. Six Englishmen are employed at each place, exclusive of blacks. A commencement has been made to lay permanent tramroad to the full extent of Treloar's level. When completed a saving in the transit of ores will be effected. Cross-cuts at Mato das Cobras and Tambor are being carried on with a fair force.—Reduction Department: Extra accommodation will have to be erected for the treatment of the increased quantity of ores at present being supplied from the mine.—Force: The attendance has been very good. The permanent machinery continues to arrive without breakage.

GENERAL BRAZILIAN.—Thomas Treloar, Feb. 26: General Operations: Our general operations since the 16th inst. have not progressed so satisfactorily. The weather, on the whole, has been fine, but we have had terrific thunderstorms. The health of the establishment is not quite so good. The ground in Itabira shallow adit is still hard, and in St. Anna shallow adit still very wet, very soft, and very troublesome. The latter is our incubus, and the difficulty of forcing it through the flookan is so great that an attempt will be made to drive shallow adit No. 2 to the lode by going around the clay. Explorations extending, particulars of which will appear in the monthly report.

ANGLO-BRAZILIAN.—Mr. F. Symons, Feb. 27: General operations are progressing satisfactorily; sick list is favourable, and attendance an average one. We are pushing on with the clearing of debris from the drained workings of the Fundao. As yet the stone is too much intermixed with extraneous matter to make a separation. Tramroads will be laid from workings to Foster's, and Foster's incline put in thorough repair, so that as much stone as possible can be hauled to surface, and the trial carried on extensively. The other sections present no alteration.

ROSSA GRANDE.—Ernest Hilcke, Feb. 26: Mine: The works have proceeded with regularity. At Mina da Serra there is little alteration to note in the appearance of the lode; that in the 40 west maintains its good size, but the standard is low. The lode in the 60 west is looking promising; it is of good quality, and to all appearance making below the level; stopes will be opened on it when the level has been extended a little further west. I hope the produce will exceed that of last month, as the samples from the stamps have shown improvement.—Cachoeira Mine: Nothing of note has occurred at this section; the works have been carried on steadily, and the preparations in hand for obtaining better ventilation will be completed in a few days.

BRAGANZA (Gold).—Capt. Roberts, Feb. 25: We are getting on as well as circumstances will admit, but being deficient in experienced masons we are in this part of the world obliged to turn our hands to all kinds of handicraft.—New Stamps: On Saturday all the arms of the wheel were fitted into the axle. We have the iron, stamp-heads, &c., here, and nearly all the iron we require for the stamps; the smiths are working early and late to complete this new mill. The tramroad is completed from the stamping-floors to the winze to convey the ore for crushing. Everything is going on satisfactorily, and the general health of the men is good.

TAQUARIL (Gold).—T. S. Treloar, Feb. 28: General Operations: Since my last report no new feature has been met with either in the mine or at any of the exploratory points calling for remark. The stamps are kept fully supplied, and I am pleased to say the mineral being treated manifests improvement in its auriferous quality. In our excavations on under lode in old workings we still have to contend with water, thereby rendering quarrying operations very difficult. The top lode has been effectually drained by a rise, which is being put to stopes from the 25 in Haymen's shaft, in the manganese lying upon the said lode, and the works on the latter will now be prosecuted without further interruption. The shoots in both lodes at present are contracted, and comparatively poor, and but little box work consequently is being obtained, but a favourable change may take place at any moment. The surface operations are now limited to tramroad from spalling-floors to stamps. Preparation of a bob and its accessories from Haymen's shaft, and running work of establishment, are advancing satisfactorily.

PACIFIC.—J. Brown, March 9: Lander Hill: In the 550 ft. level north-west the men have completed their contract of 11 ft. of ground. I shall at once commence to rise to cut the lode to drain the 400 ft. level. Our water is still very quick. The ground in the present end is a little more favourable for driving. This morning our main-rod parted about 50 ft. from surface, which has caused us a little delay in the 550 ft. level north-west. As our air-machine is worked by this rod, I hope it will be repaired by to-morrow evening. I have not set the rise yet, but will do so as soon as the air-machine is put to work.

BIRDSEYE CREEK (Gold).—The directors this morning (March 31) received the following telegram:—"Mr. Stone (the manager) has received possession on behalf of the company, and work will be commenced on the property immediately."

SWEETLAND CREEK (Gold).—The directors have received the following telegram from G. D. M'Lean, the company's agent:—"We have cleaned up, after a run of 51 days. The gross returns are $18,000. The profit is $9000. I send you a remittance of $9000 (1800*l.*)—32 days' washing.

ECLIPSE (Gold).—Mr. Tregellas, March 4: Since my last report the operations at the mine have been carried on without let or hindrance. Haymen's shaft is now sunk 37 ft. below the 220: the lode is large, and has very much improved in value; we have a considerable amount of iron pyrites in the lode, and the gold is rougher than at any other place in the mine. This speaks well for improvement in depth. The 220, driving north, is in 54 ft. from shaft; the lode here is 6 ft. wide, and has so much improved in value during the past fortnight that we are saving the whole of the gold-bearing part of the lode for the steam-mill. The silver part of the lode still holds its own, and, is in fact, looking very well indeed, which we are, as much as possible, leaving standing till we want it for the smelting furnace. The lode in the 160 is just as when last reported on—a good lode; and we are driving this, as well as other places, day and night. In the level driving south on Bluett's vein we are now stoping the bottom, the south wall of cross-course having cut out this vein at a distance of 32 ft. from the shaft. All along this level we had a beautiful hanging wall, over which was lime rock. We are now taking up the silver ore in the bottom, but at present I cannot say how large this vein is: 10 fms. below this level I put the shaftmen to drive south a few feet into the cross-course, to see if Bluett's vein had continued so far down, but I am sorry to say it does not, for in driving at this place we find what I expected—a barren cross-course. Bluett's vein can be traced from surface to, I think, the 220 ft. level, where it forms a junction with the Ellipse lode, and the same run of silver ore is now following us north, but does not run up into or down the cross-course. Our operations at the mill have been very limited indeed, for want of ironwork. But now, I am happy to inform you, I have bought the Ida mill (price 400*l.*), and other ironwork required will arrive at the mine in a day or two, and I think will be crushing within three weeks. We will work at it day and night till completed. I have let a contract for making a water ditch (to obtain water as a motive-power for the stamping mill, &c.), for the sum of $10,000, to be completed in three months from the 1st inst. And, in the meanwhile, we shall be busy putting up a 42-stamp mill, for which we have any amount of quartz, and of paying quality. I have called for tenders for building a smelting furnace up at the mine, where I believe we have many hundreds of tons of silver ore (that will yield from $200 to $400 per ton) in sight. I am getting repaired the steam engine of the late company, for the purpose of hauling the quartz and silver ore from the mine, and also to drive a blast for the smelting of the silver ores. In my next report I shall be able to tell you the exact date of starting the stamps. I feel very cheerful of our prospects, but regret the delays, the cause of which I had no control over.

BATTLE MOUNTAIN.—Captain Richards, March 9: Virgin: The 113 ft. level, west of Hallow's shaft, is progressing as favourably as the ground will admit. At present the progress is slow, ground being hard. About 9 ft., however, has been already driven on the course of the east and west lode noticed last week, which calls for no remark, except that it is easier for driving on than the ground alongside of it. But little has been done in the stopes north or south of Roach's winze (although we have raised some ore from there), as we cannot take it away so economically as we shall be enabled to do as soon as we can get the 13 holed thereto and to Roach's winze. In the 73 feet north we have driven a short distance since last report; the lode is 4 ft. wide, and is of a very encouraging character, containing good spots of green carbonate and black oxide, but not enough to value. This end should be pushed on with all speed, for the purpose of opening up and discovering another run of ore ground. The stope (Jack's stope) in the back of the 73 north contains a good lode, and some rich ore is being taken therefrom.—Lake Superior: Pryce's shaft has been temporarily suspended, and the men put to rise to surface (Moore rise) to obtain ventilation, without which the shaft cannot be sunk. The lode in the rise is 2 ft. wide, containing green carbonate of copper and small occasional strings of red oxide, and although now, as we get nearer the surface, not rich, yet I believe will produce ore enough to pay the cost of raising, judging from its present appearance. Ore shipped, 710 sacks; ores unshipped, 3529 sacks.

CAPE (Copper).—I am pleased to remark Ookiep is looking better than it ever has since I have been here, and more promising to continue.—Returns: Yield from Ookiep, 480 tons; from Spectakel, 96 tons; from reverberatory-furnace, 56 tons of regulus; from blast-furnace, 66 tons of regulus.—Transport: 345 tons of ore, and 55 tons of regulus. The Patagonia, with 185 tons of ore, had sailed from Port Nolloth, to complete cargo (about 425 tons) at Hondeklip. The Ocean King would also leave Port Nolloth with about 270 tons on about Feb. 10, to complete cargo (about 550 tons) at Hondeklip. The Tacna would probably take in a full cargo (about 590 tons) at Port Nolloth, with good dispatch.—[800 tons of ore have been put forward for sale by public ticket on April 7. Mr. Woodifield, the superintendent, was expected home by this mail, on the expiration of his engagement, but, being in ill health, would be unable to leave till the following steamer. Upon his arrival, the directors hope to be able to issue a circular to the shareholders, containing much interesting information as to the present position of the company's affairs.]

[For remainder of Foreign Mines see to-day's Journal.]

STEAM-ENGINE.—Mr. M. EYTH, Leeds, proposes to mount a cylindrical block on the crank-shaft of the engine. The axial line of the block is inclined to that of the shaft, and the block is divided longitudinally. The block is able to slide along the shaft, but it is prevented from rotating upon it by a key passed through the shaft and projecting between the two parts of the block. A plate or ring at either end of the block holds its two halves or parts together. The eccentric or tumbler, which by means of an eccentric rod, gives motion to the valve, is mounted on the block. The two projecting ends of the aforesaid key are firmly fixed to the tumbler, and prevent by this means any lateral movement of the tumbler, and compel it to revolve with the shaft. When the block is moved along the shaft it slides through a tumbler, and in consequence of its inclination to the shaft, it in so doing varies the distance of the centre of the tumbler from that of the shaft. Thus the position of the block may be set so as to give any amount of throw required to the tumbler, or by the movement of the block the centre of the tumbler may be transferred from one side of the shaft to the other, to reverse the motion of the engine.

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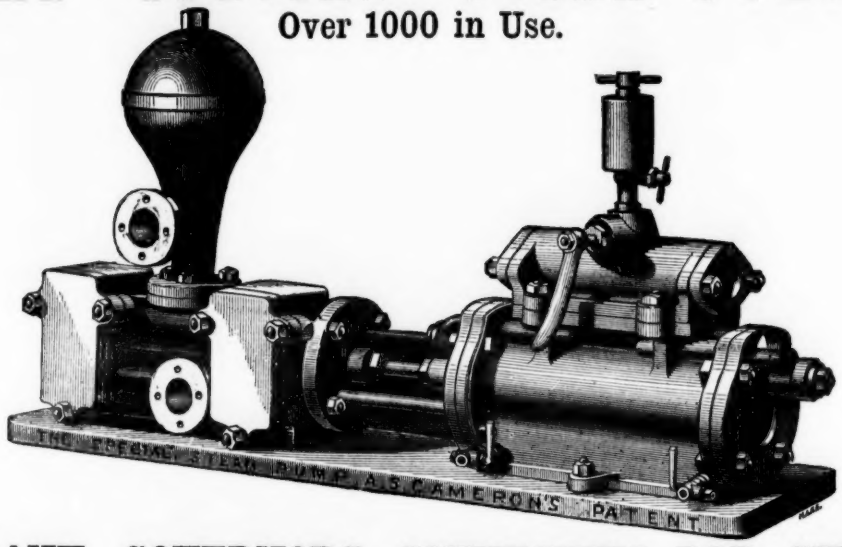
And numerous others.



NOTE.

Requires NO Shafting, Gearing, Riggers, or Belts.

All Double-Acting.

Works at any Speed, and any Pressure of Steam.

Will Force to any Height.

Delivers a constant stream.

Can be placed any distance away from a Boiler.

Occupies little space.

Simple, Durable, Economical.

NO FLY-WHEEL, CRANK, GOVERNORS, CONNECTING ROD, GUIDE, OR ECCENTRIC.

Supplied to H.M.'s Arsenal and Dockyards at Woolwich, Chatham, and Devonport, also for use on board H.M.'s Ships, Hercules and Monarch.

FORTY THOUS ND GALLONS PER HOUR IS BEING RAISED 40 FEET HIGH AT MR. McMURRAY'S PAPER MILL, WANDSWORTH, BY THE "SPECIAL" STEAM PUMP.

THE "SPECIAL" STEAM PUMP AS APPLIED TO DRAINING QUARRIES.

The engraving illustrates the "SPECIAL" Steam Pump as employed in draining quarries. At the Bangor and Carnarvon Slate Company's Quarries, in Wales, four or five of these pumps, of different dimensions, are at work, as well as at other quarries in various parts of the kingdom.

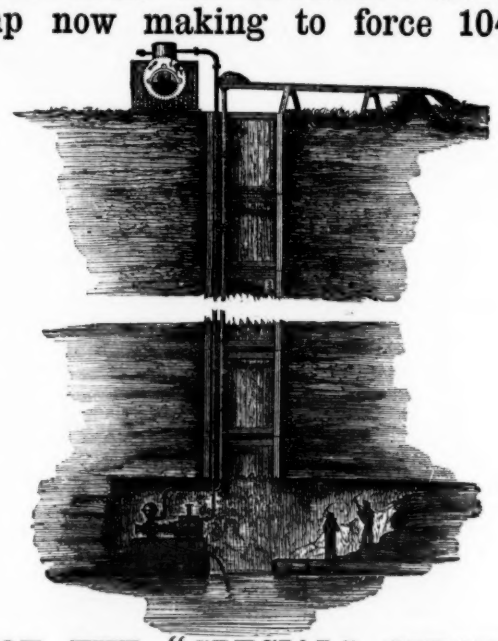
The pump being fixed in the required position, steam can be supplied by means of a felted steam-pipe from any boiler situated several hundred feet away from the pump; and although a little extra condensation would in such case take place, this system of draining quarries is found far more economical than employing detached engines and pumps, with their cumbrous details of shafting, gearing, riggers, and belts.

The "SPECIAL" Steam Pump can be adapted to work at either high or low pressure steam, and to discharge the water to a vertical height of from 200 to 400 feet. For very high lifts, pumps with long strokes are recommended.

The pump is very portable, and can be readily lowered nearer to the water as the work proceeds.

THE "SPECIAL" STEAM PUMP AS APPLIED FOR DRAINING MINES.

One "SPECIAL" Steam Pump now making to force 1040 feet in one direct lift.



The arrangement in the accompanying illustration shows an economical method of draining mines without the expense of erecting surface-engines, fixing pump-rods, or other gearing. A boiler adjacent to the pit's mouth is all that is necessary on the surface; from thence steam may readily be taken down, by means of a felted steam-pipe, to connect the pump with the boiler. The pump may be placed in any situation that may be convenient for working it, and connecting the steam, suction, and delivery pipes.

These engines can be fixed and set to work in a comparatively short time, and also at a very smal outlay. They are used in large mines as auxiliary engines, and will be found invaluable adjuncts in al mining operations.

To estimate the quantity of water to be raised by any given size of pump refer to the tabulated list below. I is recommended to use long-stroke pumps where the height exceeds 100 ft., so that the largest result may be obtained with a minimum wear and tear of the pump pistons and valves. The pumps are provided with doors for ready access to all working parts.

PRICES OF THE "SPECIAL" STEAM PUMPS.

Diameter of Steam Cylinder .....inches	2½	3	4	4	6	6	6	7	7	7	8	8	8	8	10	10	12	12	14	16	24
Diameter of Water Cylinder ....inches	1¼	1½	2	4	3	4	6	5	6	7	4	6	7	8	6	7	8	10	12	7	10
Length of Stroke ....inches	6	9	9	12	12	12	12	12	12	12	12	12	12	12	12	12	18	24	24	24	24
Strokes per minute	100	100	75	50	50	50	50	50	50	50	50	50	50	50	50	50	35	—	—	—	—
Gallons per hour	310	680	910	3250	1830	3250	7330	5070	7330	9750	3250	7330	9500	13,000	7330	9500	13,000	—	—	—	—
PRICE.....	£10	£15	£20	£35	£30	£40	£40 10	£50	£52 10	£57 10	£50	£55	£65	£75	£70	£80	£100	—	—	—	—

IF BRASS LINED, OR SOLID BRASS OR GUN-METAL WATER CYLINDERS, WITH COPPER AIR VESSELS, EXTRA, ACCORDING TO SIZE.

Any Combination can be made between the Steam and Water Cylinders, provided the Lengths of Stroke are the same, thus—8 in. Steam and 3 in. Water, or 10 in. Steam and 3 in. Water, adapted to height of lift and pressure of steam, and so on.

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London: Printed by RICHARD MIDDLETON, and published by HENRY ENGLISH (the proprietors), at their offices, 26, FLEET STREET, E.C., where all communications are requested to be addressed.—*April 1, 1871.*